PCT/EP 2004/051457

Europäisches Patentamt | European Patent Office | Office européen des brevets

12.07.04

Bescheinigung | Certificate | Attestation

Die angehefteten Unterlagen stimmen mit der ursprünglich eingereichten Fassung der auf dem nächsten Blatt bezeichneten internationalen Patentanmeldung überein.

The attached documents are exact copies of the international patent application described on the following page, as originally filed.

Les documents fixés à cette attestation sont conformes à la version initialement déposée de la demande de brevet international spécifiée à la page suivante.

Den Haag, den
The Hague,
La Haye, le 24 08. 2004

Der Präsident des Europäischen Patentamts
Im Auftrag
For the President of the European Patent Office
Le Président de l'Office européen des brevets
p.o.

Patentanmeldung Nr.
Patent application no.
Demande de brevet n° PCT/EP 03/50314

PCT/EP 2004/051457
12.07.04

Blatt 2 der Bescheinigung
Sheet 2 of the certificate
Page 2 de l'attestation

Anmeldung Nr.:
Application no.:
Demande n°: PCT/EP 03/50314

Anmelder:
Applicant(s):
Demandeur(s):
1. JANSSEN PHARMACEUTICA N.V - Beerse, Belgium
2. FREYNE, Eddy, Jean, Edgard - Beerse, Belgium (US only)
3. LOVE, Christopher, John - Beerse, Belgium (US only)

Bezeichnung der Erfindung:
Title of the invention:
Titre de l'invention: Triazolopyrimidine derivatives as glycogen synthase kinase 3 inhibitors

Anmeldetag:
Date of filing:
Date de dépôt: 16 July 2003 (16.07.2003)

In Anspruch genommene Priorität(en)
Priority(ies) claimed
Priorité(s) revendiquée(s)

Staat: State: Pays:	Tag: Date: Date:	Aktenzeichen: File no. Numéro de dépôt:

Benennung von Vertragsstaaten : Siehe Formblatt PCT/RO/101 (beigefügt)
Designation of contracting states : See Form PCT/RO/101 (enclosed)
Désignation d'états contractants : Voir Formulaire PCT/RO/101 (ci-joint)

Bemerkungen:
Remarks:
Remarques: Further applicant:

4. COOYMANS, Ludwig, Paul - Beerse, Belgium (US only)
5. BUIJNSTERS, Peter, Jacobus, Johannes, Antonius - Beerse, Belgium (US only)
6. WILLEMS, Marc - Beerse, Belgium (US only)
7. EMBRECHTS, Werner, Constant, Johan - Beerse, Belgium (US only)

PCT REQUEST

PRD2065p-PCT

Duplicate of original printed on Wednesday, 16 July, 2003 04:38:37 PM

III-6	**Applicant and/or inventor**	
III-6-1	This person is:	applicant and inventor
III-6-2	Applicant for	US only
III-6-4	Name (LAST, First)	EMBRECHTS, Werner, Constant, Johan
III-6-5	Address:	c/o Janssen Pharmaceutica N.V. Turnhoutseweg 30 B-2340 Beerse Belgium
III-6-6	State of nationality	GB
III-6-7	State of residence	BE
IV-1	**Agent or common representative; or address for correspondence** The person identified below is hereby/has been appointed to act on behalf of the applicant(s) before the competent International Authorities as:	common representative
IV-1-1	Name	JANSSEN PHARMACEUTICA N.V.
IV-1-2	Address:	Turnhoutseweg 30 B-2340 Beerse Belgium
IV-1-3	Telephone No.	00 32 14 60 38 34
IV-1-4	Facsimile No.	00 32 14 60 54 91
IV-1-5	e-mail	patents@janbe.jnj.com
V	**Designation of States**	
V-1	Regional Patent (other kinds of protection or treatment, if any, are specified between parentheses after the designation(s) concerned)	EP: AT BE BG CH&LI CY CZ DE DK EE ES FI FR GB GR HU IE IT LU MC NL PT RO SE SI SK TR and any other State which is a Contracting State of the European Patent Convention and of the PCT
V-2	National Patent (other kinds of protection or treatment, if any, are specified between parentheses after the designation(s) concerned)	US
V-5	**Precautionary Designation Statement** In addition to the designations made under items V-1, V-2 and V-3, the applicant also makes under Rule 4.9(b) all designations which would be permitted under the PCT except any designation(s) of the State(s) indicated under item V-6 below. The applicant declares that those additional designations are subject to confirmation and that any designation which is not confirmed before the expiration of 15 months from the priority date is to be regarded as withdrawn by the applicant at the expiration of that time limit.	
V-6	**Exclusion(s) from precautionary designations**	NONE

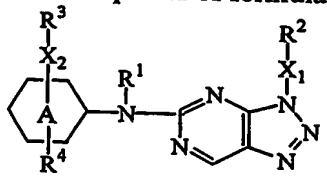
TRIAZOLOPYRIMIDINE DERIVATIVES AS GLYCOGEN SYNTHASE KINASE 3 INHIBITORS

The present invention concerns a novel group of compounds, their use as a medicine, their use for the manufacture of a medicament for the treatment of diseases mediated through glycogen synthase kinase 3 (GSK3), in particular glycogen synthase kinase 3α and 3β; processes for their preparation and pharmaceutical compositions comprising them.

WO 00/62778 describes cyclic protein tyrosine kinase inhibitors. In particular, it discloses thiazolyl derivatives comprising a bicyclic ring system.
WO 01/44246 describes bicyclic pyrimidine and pyridine based compounds having GSK3 inhibiting activity.
WO 99/65897 describes pyrimidine and pyridine based compounds having GSK3 inhibiting activity.
WO 02/04450 describes purine derivatives having the activity of either inhibiting the formation of amyloid beta or stimulating the formation of sbeta-amyloid precursor protein.

The present invention relates to compounds, which are distinguishable from the prior art in structure, pharmacological activity, potency and/or selectivity.

The present invention concerns a compound of formula (I)

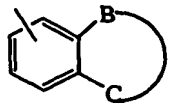


(I),

a *N*-oxide, a pharmaceutically acceptable addition salt, a quaternary amine and a stereochemically isomeric form thereof, wherein
ring A represents phenyl, pyridyl, pyrimidinyl, pyridazinyl or pyrazinyl;
R^1 represents hydrogen; aryl; formyl; C_{1-6}alkylcarbonyl; C_{1-6}alkyl; C_{1-6}alkyloxycarbonyl; C_{1-6}alkyl substituted with formyl, C_{1-6}alkylcarbonyl, C_{1-6}alkyloxycarbonyl, C_{1-6}alkylcarbonyloxy; or C_{1-6}alkyloxyC_{1-6}alkylcarbonyl optionally substituted with C_{1-6}alkyloxycarbonyl;
X_1 represents a direct bond; C_{1-4}alkyl- or -C_{1-2}alkyl-X_{1a}-X_{1b}-;
with X_{1a} representing O or NR^5; and

with X_{1b} representing a direct bond or C_{1-2}alkyl;

R^2 represents C_{3-7}cycloalkyl; phenyl or a 4, 5, 6- or 7-membered monocyclic heterocycle containing at least one heteroatom selected from O, S or N; or a radical of formula



(a-1)

wherein –B-C- represents a bivalent radical of formula

$-CH_2-CH_2-CH_2-$ (b-1);

$-CH_2-CH_2-CH_2-CH_2-$ (b-2);

$-X_3-CH_2-CH_2-(CH_2)_n-$ (b-3);

$-X_3-CH_2-(CH_2)_n-X_3-$ (b-4);

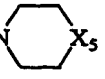
$-X_3-(CH_2)_{n'}-CH=CH-$ (b-5);

with X_3 representing O or NR^5;

n representing an integer with value 0, 1, 2 or 3;

n' representing an integer with value 0 or 1;

wherein said R^2 substituent, where possible, may optionally be substituted with at least one substituent selected from halo; hydroxy; C_{1-6}alkyl optionally substituted with at least one substituent selected from hydroxy, cyano, carboxyl, C_{1-4}alkyloxy, C_{1-4}alkylcarbonyl, C_{1-4}alkyloxycarbonyl, C_{1-4}alkylcarbonyloxy, NR^6R^7, $-C(=O)-NR^6R^7$, $-NR^5-C(=O)-NR^6R^7$, $-S(=O)_{n1}-R^8$ or $-NR^5-S(=O)_{n1}-R^8$; C_{2-6}alkenyl or C_{2-6}alkynyl, each optionally substituted with at least one substituent selected from hydroxy, cyano, carboxyl, C_{1-4}alkyloxy, C_{1-4}alkylcarbonyl, C_{1-4}alkyloxycarbonyl, C_{1-4}alkylcarbonyloxy, NR^6R^7, $-C(=O)-NR^6R^7$, $-NR^5-C(=O)-NR^6R^7$, $-S(=O)_{n1}-R^8$ or $-NR^5-S(=O)_{n1}-R^8$; polyhaloC_{1-6}alkyl; C_{1-6}alkyloxy optionally substituted with carboxyl; polyhaloC_{1-6}alkyloxy; C_{1-6}alkylthio; polyhaloC_{1-6}alkylthio; C_{1-6}alkyloxycarbonyl; C_{1-6}alkylcarbonyloxy; C_{1-6}alkylcarbonyl; polyhaloC_{1-6}alkylcarbonyl; cyano; carboxyl; NR^6R^7; $C(=O)NR^6R^7$; $-NR^5-C(=O)-NR^6R^7$; $-NR^5-C(=O)-R^5$; $-S(=O)_{n1}-R^8$; $-NR^5-S(=O)_{n1}-R^8$; -S-CN; $-NR^5-CN$ or

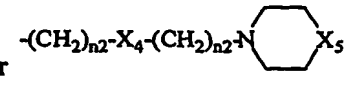


with n2 representing an integer with value 0, 1, 2, 3 or 4;

with X_4 representing O, NR^5 or a direct bond;

with X_5 representing O or NR^5;

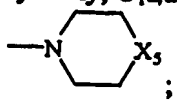
X_2 represents a direct bond; $-NR^1-$; -O-; -C(=O)-; -C(=S)-; -S-; $-S(=O)_{n1}-$; $-C_{1-4}$alkyl-; or $-C_{1-2}$alkyl-X_{1a}-X_{1b}-;

R^3 represents a 5-or 6-membered monocyclic heterocycle containing at least one heteroatom selected from O, S or N, wherein said R^3 substituent, where possible, may optionally be substituted with at least one substituent selected from halo; hydroxy; C_{1-6}alkyl optionally substituted with at least one substituent selected from hydroxy, cyano, carboxyl, C_{1-4}alkyloxy, C_{1-4}alkylcarbonyl, C_{1-4}alkyloxycarbonyl, C_{1-4}alkylcarbonyloxy, NR^6R^7, $-C(=O)-NR^6R^7$, $-NR^5-C(=O)-NR^6R^7$, $-S(=O)_{n1}-R^8$ or $-NR^5-S(=O)_{n1}-R^8$; C_{2-6}alkenyl or C_{2-6}alkynyl, each optionally substituted with at least one substituent selected from hydroxy, cyano, carboxyl, C_{1-4}alkyloxy, C_{1-4}alkylcarbonyl, C_{1-4}alkyloxycarbonyl, C_{1-4}alkylcarbonyloxy, NR^6R^7, $-C(=O)-NR^6R^7$, $-NR^5-C(=O)-NR^6R^7$, $-S(=O)_{n1}-R^8$ or $-NR^5-S(=O)_{n1}-R^8$; polyhaloC_{1-6}alkyl; C_{1-6}alkyloxy optionally substituted with carboxyl; polyhaloC_{1-6}alkyloxy; C_{1-6}alkylthio; polyhaloC_{1-6}alkylthio; C_{1-6}alkyloxycarbonyl; C_{1-6}alkylcarbonyloxy; C_{1-6}alkylcarbonyl; polyhaloC_{1-6}alkylcarbonyl; cyano; carboxyl; NR^6R^7; $C(=O)NR^6R^7$; $-NR^5-C(=O)-NR^6R^7$; $-NR^5-C(=O)-R^5$; $-S(=O)_{n1}-R^8$; $-NR^5-S(=O)_{n1}-R^8$; -S-CN; $-NR^5-CN$; or  ; and in case R^3 represents a saturated 5-or 6-membered monocyclic heterocycle containing at least one heteroatom selected from O, S or N, said R^3 may also be substituted with at least one oxo;

R^4 represents hydrogen; halo; hydroxy; C_{1-4}alkyl optionally substituted with at least one substituent selected from hydroxy, cyano, carboxyl, C_{1-4}alkyloxy, C_{1-4}alkylcarbonyl, C_{1-4}alkyloxycarbonyl, C_{1-4}alkylcarbonyloxy, NR^9R^{10}, $-C(=O)-NR^9R^{10}$, $-NR^5-C(=O)-NR^9R^{10}$, $-S(=O)_{n1}-R^{11}$ or $-NR^5-S(=O)_{n1}-R^{11}$; C_{2-4}alkenyl or C_{2-4}alkynyl, each optionally substituted with at least one substituent selected from hydroxy, cyano, carboxyl, C_{1-4}alkyloxy, C_{1-4}alkylcarbonyl, C_{1-4}alkyloxycarbonyl, C_{1-4}alkylcarbonyloxy, NR^9R^{10}, $-C(=O)-NR^9R^{10}$, $-NR^5-C(=O)-NR^9R^{10}$, $-S(=O)_{n1}-R^{11}$ or $-NR^5-S(=O)_{n1}-R^{11}$; polyhaloC_{1-3}alkyl; C_{1-4}alkyloxy optionally substituted with carboxyl; polyhaloC_{1-3}alkyloxy; C_{1-4}alkylthio; polyhaloC_{1-3}alkylthio; C_{1-4}alkyloxycarbonyl; C_{1-4}alkylcarbonyloxy; C_{1-4}alkylcarbonyl; polyhaloC_{1-4}alkylcarbonyl; nitro; cyano; carboxyl; NR^9R^{10}; $C(=O)NR^9R^{10}$; $-NR^5-C(=O)-NR^9R^{10}$; $-NR^5-C(=O)-R^5$; $-S(=O)_{n1}-R^{11}$; $-NR^5-S(=O)_{n1}-R^{11}$; -S-CN; $-NR^5-CN$;

R^5 represents hydrogen or C_{1-4}alkyl;

R^6 and R^7 each independently represent hydrogen; cyano; C_{1-6}alkylcarbonyl; C_{1-4}alkyloxyC_{1-4}alkyl; C_{1-4}alkyl-NR^5-C_{1-4}alkyl; C_{1-6}alkyl optionally substituted with

hydroxy, C_{1-4}alkyloxy, C_{1-4}alkyloxyC_{1-4}alkyloxy, $NR^{6a}R^{7a}$, $C(=O)NR^{6a}R^{7a}$,  ;

R^{6a} and R^{7a} each independently represent hydrogen; C_{1-4}alkyl; C_{1-4}alkylcarbonyl;

R^8 represents C_{1-4}alkyl, polyhaloC_{1-4}alkyl or NR^6R^7;

R^9 and R^{10} each independently represent hydrogen; C_{1-6}alkyl; cyano; C_{1-6}alkylcarbonyl; C_{1-4}alkyloxyC_{1-4}alkyl or C_{1-4}alkyl-NR^5-C_{1-4}alkyl;

R^{11} represents C_{1-4}alkyl or NR^9R^{10};

n1 represents an integer with value 1 or 2;

aryl represents phenyl or phenyl substituted with at least one substituent selected from halo, C_{1-6}alkyl, C_{3-7}cycloalkyl, C_{1-6}alkyloxy, cyano, nitro, polyhaloC_{1-6}alkyl and polyhaloC_{1-6}alkyloxy.

The present invention also relates to the use of a compound of formula (I) for the manufacture of a medicament for the prevention or the treatment of diseases mediated through GSK3.

As used herein C_{1-2}alkyl as a group or part of a group defines straight or branched chain saturated hydrocarbon radicals having from 1 to 2 carbon atoms such as methyl, ethyl; C_{1-3}alkyl as a group or part of a group defines straight or branched chain saturated hydrocarbon radicals having from 1 to 3 carbon atoms such as the groups defined for C_{1-2}alkyl and propyl, 1-methylethyl; C_{1-4}alkyl as a group or part of a group defines straight or branched chain saturated hydrocarbon radicals having from 1 to 4 carbon atoms such as the groups defined for C_{1-3}alkyl and butyl; C_{1-6}alkyl as a group or part of a group defines straight or branched chain saturated hydrocarbon radicals having from 1 to 6 carbon atoms such as the groups defined for C_{1-4}alkyl and pentyl, hexyl, 2-methylbutyl and the like; C_{2-4}alkenyl as a group or part of a group defines straight and branched chain hydrocarbon radicals having from 2 to 4 carbon atoms containing a double bond such as ethenyl, propenyl, butenyl and the like; C_{2-6}alkenyl as a group or part of a group defines straight and branched chain hydrocarbon radicals having from 2 to 6 carbon atoms containing a double bond such as the groups defined for C_{2-4}alkenyl and pentenyl, hexenyl and the like; C_{2-4}alkynyl as a group or part of a group defines straight and branched chain hydrocarbon radicals having from 2 to 4 carbon atoms containing a triple bond such as ethynyl, propynyl, butynyl and the like; C_{2-6}alkynyl as a group or part of a group defines straight and branched chain hydrocarbon radicals having from 2 to 6 carbon atoms containing a triple bond such as the group defined for C_{2-4}alkynyl and pentynyl, hexynyl and the like; C_{3-7}cycloalkyl is generic to cyclo-

propyl, cyclobutyl, cyclopentyl, cyclohexyl and cycloheptyl; a 4, 5, 6- or 7-membered monocyclic heterocycle containing at least one heteroatom selected from O, S or N comprises saturated, partially saturated or aromatic 4, 5, 6- or 7-membered monocyclic heterocycles containing at least one heteroatom selected from O, N or S; saturated heterocyles are heterocycles containing only single bonds; partially saturated heterocycles are heterocycles containing at least one double bond provided that the ring system is not an aromatic ring system; the term aromatic is well known to a person skilled in the art and designates cyclically conjugated systems of 4n' + 2 electrons, that is with 6, 10, 14 etc. π-electrons (rule of Hückel; n' being 1, 2,3 etc.).

Particular examples of 4, 5, 6- or 7-membered saturated monocyclic heterocycles are azetidinyl, oxetanyl, tetrahydrofuranyl, pyrrolidinyl, dioxolanyl, imidazolidinyl, thiazolidinyl, tetrahydrothienyl, dihydrooxazolyl, isothiazolidinyl, isoxazolidinyl, oxadiazolidinyl, triazolidinyl, thiadiazolidinyl, pyrazolidinyl, piperidinyl, hexahydropyrimidinyl, hexahydropyridazinyl, dioxanyl, morpholinyl, dithianyl, thiomorpholinyl, piperazinyl, homopiperidinyl (azepanyl), [1,3]diazepanyl, homopiperazinyl ([1,4]diazepanyl), [1,2]diazepanyl, oxepanyl, dioxepanyl.

Particular examples of 5- or 6-membered partially saturated heterocycles are pyrrolinyl, imidazolinyl, pyrazolinyl and the like.

Particular examples of 4, 5, 6- or 7-membered aromatic monocyclic heterocycles are pyrrolyl, furyl, thienyl, imidazolyl, oxazolyl, isoxazolyl, thiazolyl, isothiazolyl, pyrazolyl, triazolyl, thiadiazolyl, oxadiazolyl, tetrazolyl, pyridyl, pyrimidinyl, pyrazinyl, pyridazinyl.

As used herein before, the term (=O) forms a carbonyl moiety when attached to a carbon atom, a sulfoxide moiety when attached to a sulfur atom and a sulfonyl moiety when two of said terms are attached to a sulfur atom.

Examples of R^3 representing a saturated 5-or 6-membered monocyclic heterocycle containing at least one heteroatom selected from O, S or N, wherein said R^3 is substituted with at least one oxo are e.g. cyclohexanone or tetrahydro-1,1-dioxide-2*H*-thiopyran.

The term halo is generic to fluoro, chloro, bromo and iodo. As used in the foregoing and hereinafter, polyhaloC_{1-6}alkyl as a group or part of a group is defined as mono- or

polyhalosubstituted C_{1-6}alkyl, for example, methyl substituted with one or more fluoro atoms, for example, difluoromethyl or trifluoromethyl, 1,1-difluoro-ethyl and the like. In case more than one halogen atoms are attached to an alkyl group within the definition of polyhalomethyl or polyhaloC_{1-6}alkyl, they may be the same or different.

The term heterocycle as in the definition of for instance R^2 or R^3 is meant to include all the possible isomeric forms of the heterocycles, for instance, pyrrolyl also includes 2*H*-pyrrolyl.

The hereinabove-mentioned heterocycles may be attached to the remainder of the molecule of formula (I) through any ring carbon or heteroatom as appropriate, if not otherwise specified. Thus, for example, when the 5- or 6-membered heterocycle is imidazolyl, it may be 1-imidazolyl, 2-imidazolyl, 4-imidazolyl and the like.

When any variable (eg. R^6, R^7 etc.) occurs more than one time in any constituent, each definition is independent.

Lines drawn into ring systems from substituents indicate that the bond may be attached to any of the suitable ring atoms of the ring system.

For therapeutic use, salts of the compounds of formula (I) are those wherein the counterion is pharmaceutically acceptable. However, salts of acids and bases which are non-pharmaceutically acceptable may also find use, for example, in the preparation or purification of a pharmaceutically acceptable compound. All salts, whether pharmaceutically acceptable or not are included within the ambit of the present invention.

The pharmaceutically acceptable addition salts as mentioned hereinabove are meant to comprise the therapeutically active non-toxic acid addition salt forms which the compounds of formula (I) are able to form. The latter can conveniently be obtained by treating the base form with such appropriate acids as inorganic acids, for example, hydrohalic acids, e.g. hydrochloric, hydrobromic and the like; sulfuric acid; nitric acid; phosphoric acid and the like; or organic acids, for example, acetic, propanoic, hydroxy-acetic, 2-hydroxypropanoic, 2-oxopropanoic, oxalic, malonic, succinic, maleic, fumaric, malic, tartaric, 2-hydroxy-1,2,3-propanetricarboxylic, methanesulfonic, ethanesulfonic, benzenesulfonic, 4-methylbenzenesulfonic, cyclohexanesulfamic,

2-hydroxybenzoic, 4-amino-2-hydroxybenzoic and the like acids. Conversely the salt form can be converted by treatment with alkali into the free base form.

The compounds of formula (I) containing acidic protons may be converted into their therapeutically active non-toxic metal or amine addition salt forms by treatment with appropriate organic and inorganic bases. Appropriate base salt forms comprise, for example, the ammonium salts, the alkali and earth alkaline metal salts, e.g. the lithium, sodium, potassium, magnesium, calcium salts and the like, salts with organic bases, e.g. primary, secondary and tertiary aliphatic and aromatic amines such as methylamine, ethylamine, propylamine, isopropylamine, the four butylamine isomers, dimethylamine, diethylamine, diethanolamine, dipropylamine, diisopropylamine, di-n-butylamine, pyrrolidine, piperidine, morpholine, trimethylamine, triethylamine, tripropylamine, quinuclidine, pyridine, quinoline and isoquinoline, the benzathine, *N*-methyl-D-glucamine, 2-amino-2-(hydroxymethyl)-1,3-propanediol, hydrabamine salts, and salts with amino acids such as, for example, arginine, lysine and the like. Conversely the salt form can be converted by treatment with acid into the free acid form.

The term addition salt also comprises the hydrates and solvent addition forms which the compounds of formula (I) are able to form. Examples of such forms are e.g. hydrates, alcoholates and the like.

The term "quaternary amine" as used hereinbefore defines the quaternary ammonium salts which the compounds of formula (I) are able to form by reaction between a basic nitrogen of a compound of formula (I) and an appropriate quaternizing agent, such as, for example, an optionally substituted alkylhalide, arylhalide or arylalkylhalide, e.g. methyliodide or benzyliodide. Other reactants with good leaving groups may also be used, such as alkyl trifluoromethanesulfonates, alkyl methanesulfonates, and alkyl p-toluenesulfonates. A quaternary amine has a positively charged nitrogen. Pharmaceutically acceptable counterions include chloro, bromo, iodo, trifluoroacetate and acetate. The counterion of choice can be introduced using ion exchange resins.

The *N*-oxide forms of the present compounds are meant to comprise the compounds of formula (I) wherein one or several tertiary nitrogen atoms are oxidized to the so-called *N*-oxide.

The term "stereochemically isomeric forms" as used hereinbefore defines all the possible stereoisomeric forms which the compounds of formula (I), and their *N*-oxides,

addition salts, quaternary amines or physiologically functional derivatives may possess. Unless otherwise mentioned or indicated, the chemical designation of compounds denotes the mixture of all possible stereochemically isomeric forms, said mixtures containing all diastereomers and enantiomers of the basic molecular structure as well as each of the individual isomeric forms of formula (I) and their *N*-oxides, salts, solvates or quaternary amines substantially free, *i.e.* associated with less than 10%, preferably less than 5%, in particular less than 2% and most preferably less than 1% of the other isomers. In particular, stereogenic centers may have the R- or S-configuration; substituents on bivalent cyclic (partially) saturated radicals may have either the *cis*- or *trans*-configuration. Compounds encompassing double bonds can have an E or Z-stereochemistry at said double bond. Stereochemically isomeric forms of the compounds of formula (I) are obviously intended to be embraced within the scope of this invention.

The *N*-oxide forms of the present compounds are meant to comprise the compounds of formula (I) wherein one or several tertiary nitrogen atoms are oxidized to the so-called *N*-oxide.

Some of the compounds of formula (I) may also exist in their tautomeric form (e.g. keto-enol tautomerism). Such forms although not explicitly indicated in the above formula are intended to be included within the scope of the present invention.

Whenever used hereinafter, the term "compounds of formula (I)" is meant to also include their *N*-oxide forms, their salts, their quaternary amines and their stereochemically isomeric forms. Of special interest are those compounds of formula (I) which are stereochemically pure.

Interesting compounds are those compounds of formula (I) as defined hereinabove, their *N*-oxides, pharmaceutically acceptable addition salts, quaternary amines and stereochemically isomeric forms thereof, wherein

ring A is phenyl or pyridyl;

R^1 is hydrogen or C_{1-6}alkyl;

X_1 is direct bond or C_{1-4}alkyl;

R^2 is phenyl; cyclohexyl; piperidinyl; indanyl; 2,3-dihydro-1,4-benzodioxanyl; said rings representing R^2 optionally being substituted with at least one substituent selected independently from C_{1-6}alkyl; C_{1-6}alkyloxy; halo; C_{1-6}alkylthio;

hydroxyC_{1-6}alkyl; aminocarbonyl; (C_{1-6}alkyl)(C_{1-6}alkylcarbonyl)amino; polyhaloC_{1-6}alkyl; C_{1-6}alkyloxycarbonyl;

X_2 is direct bond or NR^1;

R^3 is tetrazolyl; morpholinyl; piperazinyl; imidazolyl; oxazolyl; oxadiazolyl; pyrimidinyl; thiazolyl; triazolyl; pyridyl; pyrazinyl; pyrazolyl; pyrrolyl; said rings representing R^3 optionally being substituted with at least one substitutent selected independently from C_{1-6}alkyl; amino; halo; hydroxy; mono(C_{1-6}alkyl)amino; -NH-CN;

R^4 is hydrogen or nitro.

Further interesting compounds are those compounds of formula (I) as defined hereinabove, their *N*-oxides, pharmaceutically acceptable addition salts, quaternary amines and stereochemically isomeric forms thereof, wherein the X_2-R^3 substituent is linked to ring A in metaposition compared to the NR^1 linker.

Also interesting compounds are those compounds of formula (I) as defined hereinabove, their *N*-oxides, pharmaceutically acceptable addition salts, quaternary amines and stereochemically isomeric forms thereof, wherein the R^4 substituent is linked to ring A in paraposition compared to the NR^1 linker.

Interesting compounds are also those compounds of formula (I) as defined hereinabove, their *N*-oxides, pharmaceutically acceptable addition salts, quaternary amines and stereochemically isomeric forms thereof, wherein the R^2 substituent is unsubstituted or substituted with 1 , 2 or 3 substituents, in particular the R^2 substituent is unsubstituted or substituted with 1 or 2 substituents.

Also interesting are those compounds of formula (I) as defined hereinabove, their *N*-oxides, pharmaceutically acceptable addition salts, quaternary amines and stereochemically isomeric forms thereof, wherein the R^3 substituent is unsubstituted or substituted with 1 , 2 or 3 substituents, in particular the R^3 substituent is unsubstituted or substituted with 1 substituent.

Particular interesting compounds are those compounds of formula (I) as defined hereinabove, their *N*-oxides, pharmaceutically acceptable addition salts, quaternary amines and stereochemically isomeric forms thereof, wherein

ring A is phenyl;

R^1 is hydrogen;

X_1 is direct bond;

R^2 is indanyl; 2,3-dihydro-1,4-benzodioxanyl; phenyl optionally being substituted with 1 or 2 substituents each independently being selected from C_{1-6}alkyl, in particular methyl; C_{1-6}alkyloxy, in particular methoxy; halo, in particular fluoro, or polyhaloC_{1-6}alkyl, in particular trifluoromethyl;

X_2 is direct bond;

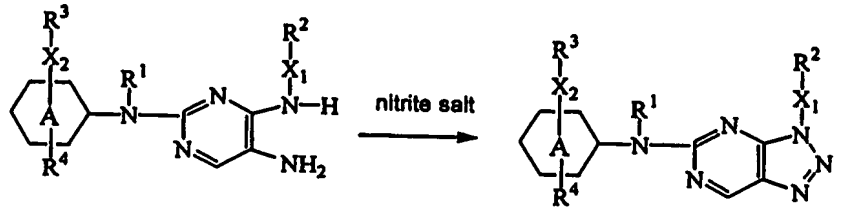
R^3 is tetrazolyl; piperazinyl; imidazolyl; oxazolyl; pyrimidinyl; thiazolyl; triazolyl; pyridyl; pyrazinyl; pyrazolyl; said rings representing R^3 optionally being substituted with one substitutent selected from C_{1-6}alkyl, in particular methyl; amino; hydroxy; mono(C_{1-6}alkyl)amino, in particular methylamino; -NH-CN;

R^4 is hydrogen.

Preferred compounds of formula (I) are compounds 17, 3, 24, 14, 63, 66, 65, 33, 34, 22, 35, 47, 43, 9, 31, 23, 1, 32, 42, 52, 40, 30, 21, 20, 27, 2, 36, as listed in Tables 1 to 3 hereinafter, their *N*-oxides, pharmaceutically acceptable addition salts, quaternary amines and stereochemically isomeric forms thereof.

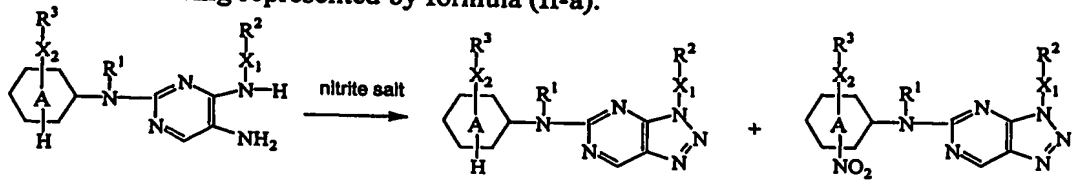
Most preferred compounds of formula (I) are selected from :
3-(3-Fluoro-phenyl)-3H-[1,2,3]triazolo[4,5-d]pyrimidin-5-yl]-(3-oxazol-5-yl-phenyl)-amine;
[3-(3-Fluoro-phenyl)-3H-[1,2,3]triazolo[4,5-d]pyrimidin-5-yl]-[3-(1-methyl-1H-tetrazol-5-yl)-phenyl]-amine;
[3-(2-Amino-pyrimidin-4-yl)-phenyl]-[3-(3-fluoro-phenyl)-3H-[1,2,3]triazolo[4,5-d]pyrimidin-5-yl]-amine;
[3-(3-Fluoro-phenyl)-3H-[1,2,3]triazolo[4,5-d]pyrimidin-5-yl]-(3-pyrimidin-5-yl-phenyl)-amine; a *N*-oxide, a pharmaceutically acceptable addition salt, a quaternary amine and a stereochemically isomeric form thereof.

Compounds of formula (I) can be prepared by cyclizing an intermediate of formula (II) in the presence of a nitrite salt, such as for example $NaNO_2$, a suitable solvent, such as for example water, and a suitable acid, such as for example hydrochloric acid and/or acetic acid and the like.



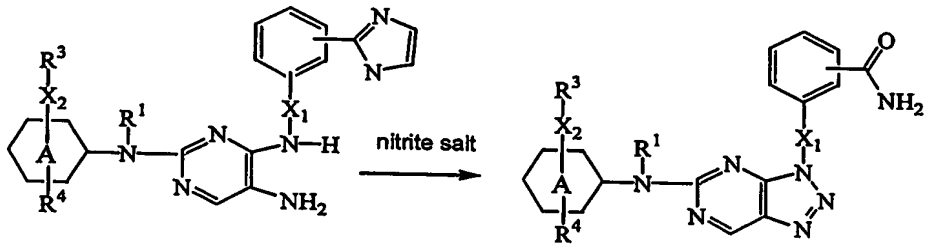
(II) (I)

The above reaction can also be used to prepare compounds of formula (I) wherein R^4 represents either hydrogen or nitro, said compounds being represented by formula (I-a) and (I-b), from an intermediate of formula (II) wherein R^4 represents hydrogen, said intermediate being represented by formula (II-a).



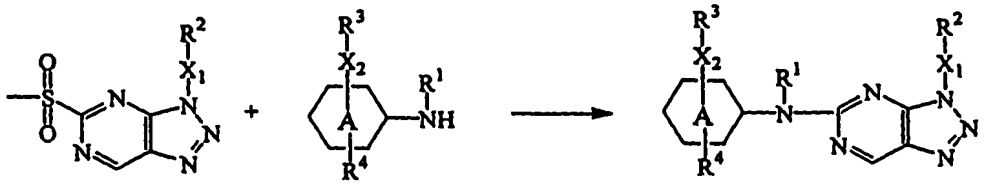
(II-a) (I-a) (I-b)

The above reaction can also be used to prepare a compound of formula (I) wherein R^2 represents a phenyl ring substituted with aminocarbonyl, said compound being represented by formula (I-c), from an intermediate of formula (II) wherein R^2 represents a phenyl ring substituted with an imidazole moiety, said intermediate being represented by formula (II-b).

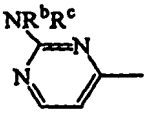


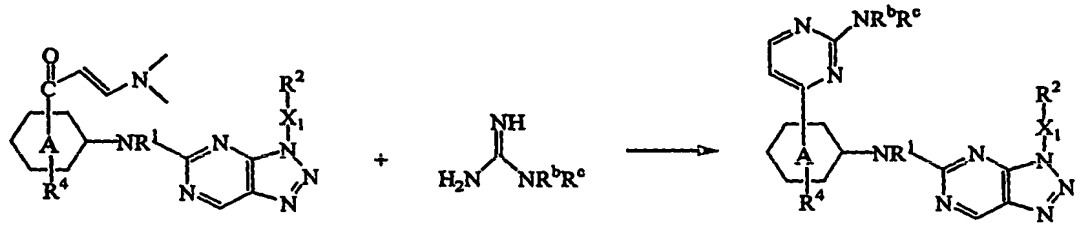
(II-b) (I-c)

Compounds of formula (I) can also be prepared by reacting an intermediate of formula (III) with an intermediate of formula (IV) in the presence of a suitable solvent, such as for example dimethylsulfoxide, CH_3-O-CH_2-CH_2-OH or $(CH_3)_2$N-C(=O)H in the presence of NaH.

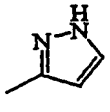


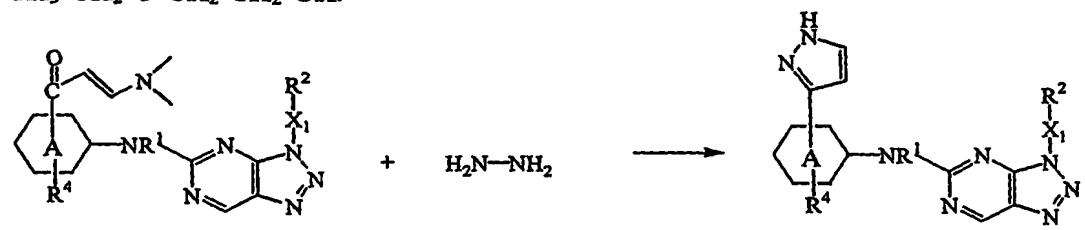
(III) (IV) (I)

Compounds of formula (I) wherein X_2-R^3 represents  , wherein R^b represents hydrogen, C_{1-4}alkyl or cyano, and R^c represents hydrogen or C_{1-4}alkyl, said compounds being represented by formula (I-d), can be prepared by reacting an intermediate of formula (XV) with an intermediate of formula (XVI) in the presence of a suitable solvent, such as for example CH_3-CH_2-O-CH_2-CH_2-OH, and a suitable salt, such as for example sodium methanolate.



(XV) (XVI) (I-d)

Compounds of formula (I) wherein X_2-R^3 represents  , said compounds being represented by formula (I-e), can be prepared by reacting an intermediate of formula (XV) with hydrazine in the presence of a suitable solvent, such as for example CH_3-CH_2-O-CH_2-CH_2-OH.



(XV) (I-e)

In this and the following preparations, the reaction products may be isolated from the reaction medium and, if necessary, further purified according to methodologies

generally known in the art such as, for example, extraction, crystallization, distillation, trituration and chromatography.

The compounds of formula (I) may further be prepared by converting compounds of formula (I) into each other according to art-known group transformation reactions.

The compounds of formula (I) may be converted to the corresponding *N*-oxide forms following art-known procedures for converting a trivalent nitrogen into its *N*-oxide form. Said *N*-oxidation reaction may generally be carried out by reacting the starting material of formula (I) with an appropriate organic or inorganic peroxide. Appropriate inorganic peroxides comprise, for example, hydrogen peroxide, alkali metal or earth alkaline metal peroxides, e.g. sodium peroxide, potassium peroxide; appropriate organic peroxides may comprise peroxy acids such as, for example, benzenecarboperoxoic acid or halo substituted benzenecarboperoxoic acid, e.g. 3-chlorobenzenecarboperoxoic acid, peroxoalkanoic acids, e.g. peroxoacetic acid, alkylhydroperoxides, e.g. t.butyl hydro-peroxide. Suitable solvents are, for example, water, lower alcohols, e.g. ethanol and the like, hydrocarbons, e.g. toluene, ketones, e.g. 2-butanone, halogenated hydrocarbons, e.g. dichloromethane, and mixtures of such solvents.

Compounds of formula (I) wherein R^2 is a ring system substituted with halo, e.g. bromo, can be converted into a compound of formula (I) wherein said R^2 substituent is unsubstituted, in the presence of H_2 and in the presence of a suitable catalyst, such as for example palladium on charcoal, a suitable catalyst poison, such as for example a thiophene solution, a suitable base, such as for example *N*,*N*-diethylethanamine, and a suitable solvent, such as for example tetrahydrofuran.

Compounds of formula (I) wherein R^2 is substituted with halo can also be converted into a compound of formula (I) wherein R^2 is substituted with C_{1-6}alkylthio, by reaction with a reagent of formula alkaline metal$^+$ $^-$S-C_{1-6}alkyl, e.g. Na^+ $^-$S-C_{1-6}alkyl, in the presence of a suitable solvent, such as *N*,*N*-dimethylsulfoxide. The latter compounds can further be converted into a compound of formula (I) wherein R^2 is substituted with C_{1-6}alkyl-S(=O)-, by reaction with a suitable oxidizing agent, such as a peroxide, e.g. 3-chlorobenzenecarboperoxoic acid, in the presence of a suitable solvent, such as an alcohol, e.g. ethanol.

Compounds of formula (I) wherein R^2 is substituted with halo can also be converted into a compound of formula (I) wherein R^2 is substituted with C_{1-6}alkyloxy, by reaction

with an alcoholate salt, such as, for example, $LiOC_{1-6}$alkyl, in the presence of a suitable solvent, such as an alcohol, e.g. methanol.

Compounds of formula (I) wherein R^2 is substituted with halo can also be converted into a compound of formula (I) wherein R^2 is substituted with hydroxy, by reaction with a suitable carboxylate, e.g. sodium acetate, in a suitable reaction-inert solvent, such as, for example, *N,N*-dimethylsulfoxide, followed by treating the obtained reaction product with a suitable base, such as pyridine.

Compounds of formula (I) wherein R^2 is substituted with chloro, can be converted into a compound of formula (I) wherein R^2 is substituted with fluoro, by reaction with a suitable fluoride salt, such as for example potassium fluoride, in the presence of a suitable solvent, e.g. sulfolane.

Compounds of formula (I) wherein R^2 is substituted with C_{1-4}alkyloxyC_{1-6}alkyl, can be converted into a compound of formula (I) wherein R^2 is substituted with hydroxyC_{1-6}alkyl, by dealkylating the ether in the presence of a suitable dealkylating agent, such as, for example, tribromoborane, and a suitable solvent, such as methylene chloride.

Compounds of formula (I) wherein R^2 is substituted with C_{1-6}alkyloxycarbonyl, can be converted into a compound of formula (I) wherein R^2 is substituted with aminocarbonyl or mono- or di(C_{1-6}alkyl)aminocarbonyl by reaction with a suitable agent such as ammonia, $NH_2(C_{1-6}alkyl)$, $AlCH_3[N(C_{1-6}alkyl)_2]Cl$ optionally in the presence of a suitable acid, such as for example hydrochloric acid, and in the presence of a suitable solvent such as an alcohol, e.g. methanol; tetrahydrofuran; *N,N*-diisopropylethane.

Compounds of formula (I) wherein R^2 is unsubstituted can be converted into a compound wherein R^2 is substituted with halo, by reaction with a suitable halogenating agent, such as, for example Br_2 or 1-(chloromethyl)-4-fluoro-1,4-diazoniabicyclo[2,2,2]octane bis[tetrafluoroborate], in the presence of a suitable solvent, such as tetrahydrofuran, water, acetonitrile, chloroform and optionally in the presence of a suitable base such as *N,N*-diethylethanamine.

Compounds of formula (I) wherein R^2 is substituted with C_{1-6}alkyloxycarbonyl, can be converted into a compound of formula (I) wherein R^2 is substituted with hydroxymethyl by reaction with a suitable reducing agent, such as for example $LiAlH_4$.

Compounds of formula (I) wherein R^2 is substituted with NH_2 can be converted into a compound of formula (I) wherein R^2 is substituted with $NH\text{-}S(=O)_2\text{-}NR^6R^7$ by reaction with $W_1\text{-}S(=O)_2\text{-}NR^6R^7$ wherein W_1 represents a suitable leaving group such as for example a halo atom, e.g. chloro, in the presence of a suitable solvent, such as for example *N,N*-dimethylacetamide and a suitable base, such as for example *N,N*-diethylethanamine.

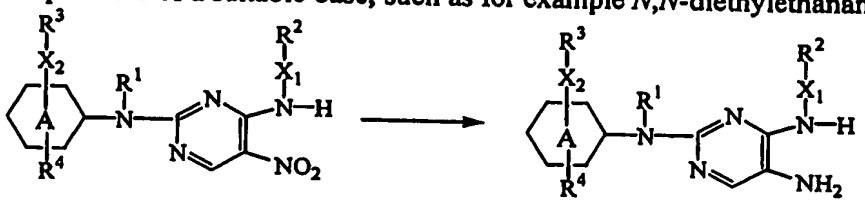
Some of the compounds of formula (I) and some of the intermediates in the present invention may consist of a mixture of stereochemically isomeric forms. Pure stereochemically isomeric forms of said compounds and said intermediates can be obtained by the application of art-known procedures. For example, diastereoisomers can be separated by physical methods such as selective crystallization or chromatographic techniques, e.g. counter current distribution, liquid chromatography and the like methods. Enantiomers can be obtained from racemic mixtures by first converting said racemic mixtures with suitable resolving agents such as, for example, chiral acids, to mixtures of diastereomeric salts or compounds; then physically separating said mixtures of diastereomeric salts or compounds by, for example, selective crystallization or chromatographic techniques, e.g. liquid chromatography and the like methods; and finally converting said separated diastereomeric salts or compounds into the corresponding enantiomers. Pure stereochemically isomeric forms may also be obtained from the pure stereochemically isomeric forms of the appropriate intermediates and starting materials, provided that the intervening reactions occur stereospecifically.

An alternative manner of separating the enantiomeric forms of the compounds of formula (I) and intermediates involves liquid chromatography, in particular liquid chromatography using a chiral stationary phase.

Some of the intermediates and starting materials are known compounds and may be commercially available or may be prepared according to art-known procedures.

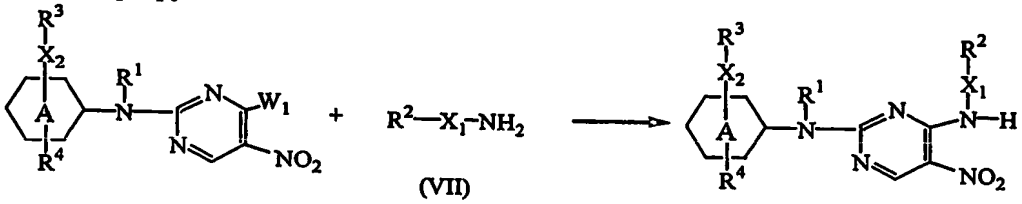
Intermediates of formula (II) can be prepared by reducing an intermediate of formula (V) with a suitable reducing agent, such as for example H_2, in the presence of a suitable catalyst, such as for example platina on charcoal or palladium on charcoal, optionally in the presence of a suitable catalyst poison, such as for example a thiophene solution, optionally in the presence of $NH_2\text{-}NH_2$, in the presence of a suitable solvent, such as for

example *N,N*-dimethylacetamide, tetrahydrofuran, *N,N*-dimethylformamide or a suitable alcohol, such as for example methanol, ethanol and the like, and optionally in the presence of a suitable base, such as for example *N,N*-diethylethanamine.



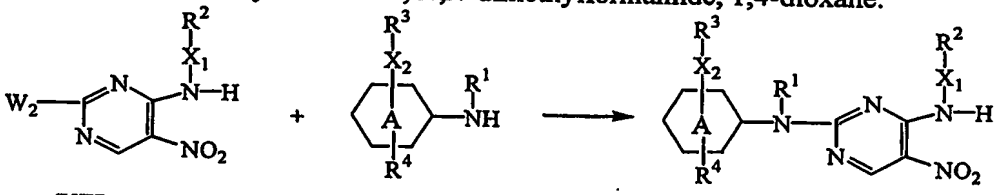
(V) (II)

Intermediates of formula (V) can be prepared by reacting an intermediate of formula (VI) wherein W_1 represents a suitable leaving group, such as for example halogen, e.g. chloro and the like, with an intermediate of formula (VII) in the presence of a suitable solvent, such as for example *N,N*-dimethylacetamide or an alcohol, e.g. ethanol and the like, and optionally in the presence of a suitable base, such as for example *N,N*-diisopropylethanamine.

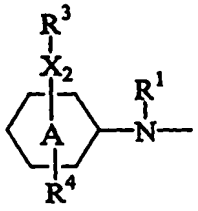


(VI) (VII) (V)

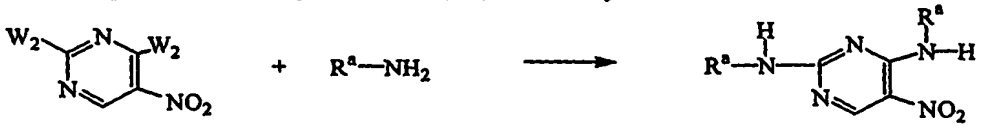
Intermediates of formula (V) can also be prepared by reacting an intermediate of formula (VIII) wherein W_2 represents a suitable leaving group, such as for example halogen, e.g. chloro and the like, with an intermediate of formula (IV) in the presence of a suitable base, such as for example *N,N*-diisopropylethanamine or *N,N*-diethylethanamine, and optionally in the presence of a suitable solvent, such as for example *N,N*-dimethylacetamide, *N,N*-dimethylformamide, 1,4-dioxane.



(VIII) (IV) (V)

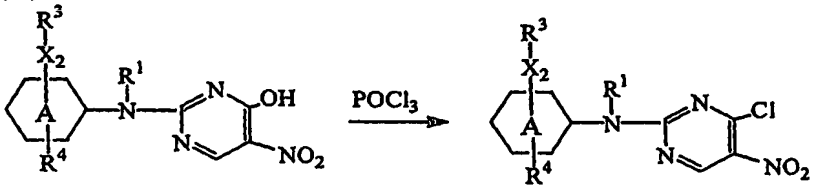


Intermediates of formula (V) wherein R^2-X_1-NH-and the moiety represent the same substituent being represented by R^a-NH-, said intermediates being represented by formula (V-a), can be prepared by reacting an intermediate of formula (IX) wherein W_2 is defined as hereinabove, with R^a-NH_2 in the presence of a suitable base, such as for example *N,N*-diisopropylethanamine, and a suitable solvent, such as for example *N,N*-dimethylacetamide, *N,N*-dimethylformamide or CH_2Cl_2.



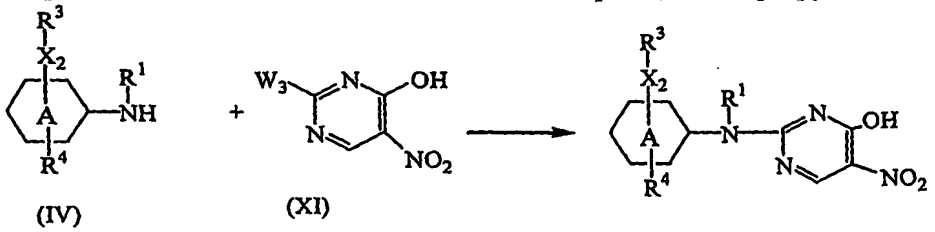
(IX) (V-a)

Intermediates of formula (VI) wherein W_1 represents chloro, said intermediates being represented by formula (VI-a), can be prepared by reacting an intermediate of formula (X) with $POCl_3$.



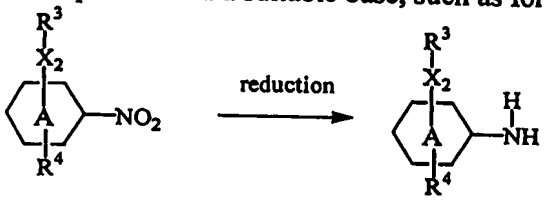
(X) (VI-a)

Intermediates of formula (X) can be prepared by reacting an intermediate of formula (IV) with an intermediate of formula (XI) wherein W_3 represents a suitable leaving group, such as for example halogen, e.g. chloro, in the presence of a suitable solvent, such as for example tetrahydrofuran and water, or CH_3-O-$(CH_2)_2$-OH, and optionally in the presence of a suitable base, such as for example *N,N*-diisopropylethanamine.

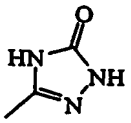


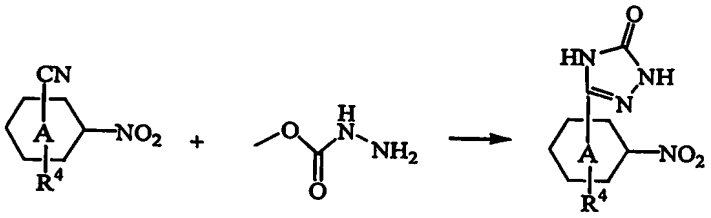
(IV) (XI) (X)

Intermediates of formula (IV) wherein R^1 represents hydrogen, said intermediates being represented by formula (IV-a), can be prepared by reacting an intermediate of formula (IV-b) with a suitable reducing agent, such as for example H_2, in the presence of a suitable catalyst, such as for example platina on charcoal or palladium on charcoal, optionally a suitable catalyst poison, such as for example a thiophene solution, a suitable solvent, such as for example *N,N*-dimethylacetamide, tetrahydrofuran, *N,N*-dimethylformamide or a suitable alcohol, such as for example methanol, and optionally in the presence of a suitable base, such as for example *N,N*-diethylethanamine.



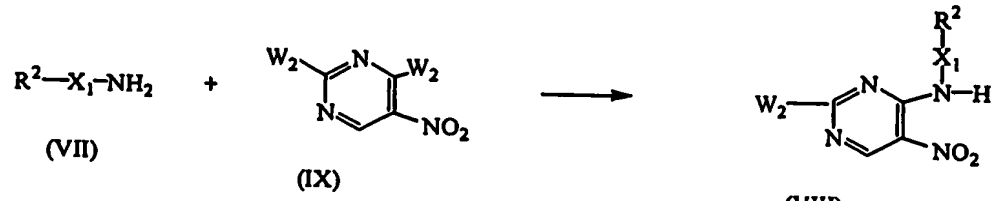
(IV-b) (IV-a)

Intermediates of formula (IV-b) wherein X_2 is a direct bond and R^3 is  , said intermediates being represented by formula (IV-b-1), can be prepared by reacting an intermediate of formula (IV-c) with CH_3O-C(=O)-NH-NH_2, in the presence of a suitable solvent, such as an alcohol, e.g. ethanol and the like, and a suitable alcoholate, such as for example sodium ethanolate and the like.



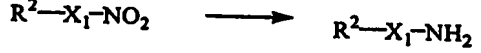
(IV-c) (IV-b-1)

Intermediates of formula (VIII) can be prepared by reacting an intermediate of formula (VII) with an intermediate of formula (IX) in the presence of a suitable solvent, such as for example *N,N*-dimethylacetamide, *N,N*-dimethylformamide, CH_2Cl_2 or 1,4-dioxane, and optionally in the presence of a suitable base, such as for example *N,N*-diisopropylethanamine.



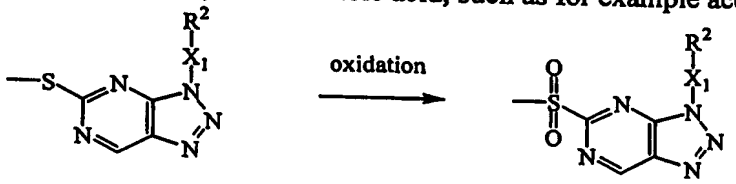
(VII) (IX) (VIII)

Intermediates of formula (VII) can be prepared by reducing an intermediate of formula (VII-a) in the presence of Fe and an ammonium chloride solution.



(VII-a) (VII)

Intermediates of formula (III) can be prepared by reacting an intermediate of formula (XII) with a suitable oxidizing agent, such as for example $KMnO_4$ or meta-chloro-perbenzoic acid, in the presence of a suitable solvent, such as for example water or CH_2Cl_2, and a suitable acid, such as for example acetic acid.



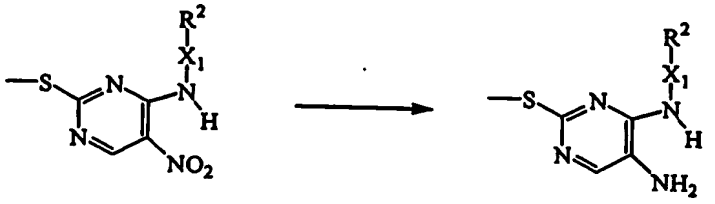
(XII) (III)

Intermediates of formula (XII) can be prepared by reacting an intermediate of formula (XIII) with a nitrite salt, such as for example $NaNO_2$, a suitable solvent, such as for example water, and a suitable acid, such as for example hydrochloric acid and/or acetic acid and the like.

(XIII) (XII)

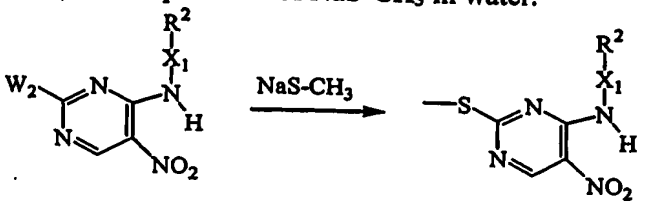
Intermediates of formula (XIII) can be prepared by reacting an intermediate of formula (XIV) with a suitable reducing agent, such as for example H_2, in the presence of a suitable catalyst, such as for example platina on charcoal or palladium on charcoal, optionally a suitable catalyst poison, such as for example a thiophene solution, a suitable solvent, such as for example *N,N*-dimethylacetamide, tetrahydrofuran, *N,N*-dimethylformamide or a suitable alcohol, such as for example methanol, and

optionally in the presence of a suitable base, such as for example *N,N*-diethylethanamine.



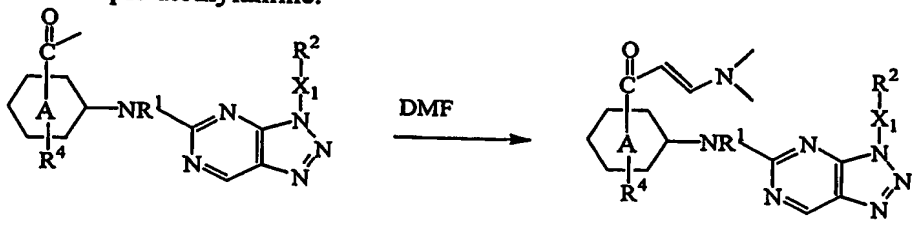
(XIV) (XIII)

Intermediates of formula (XIV) can be prepared by reacting an intermediate of formula (VIII), in the presence of $NaS\text{-}CH_3$ in water.



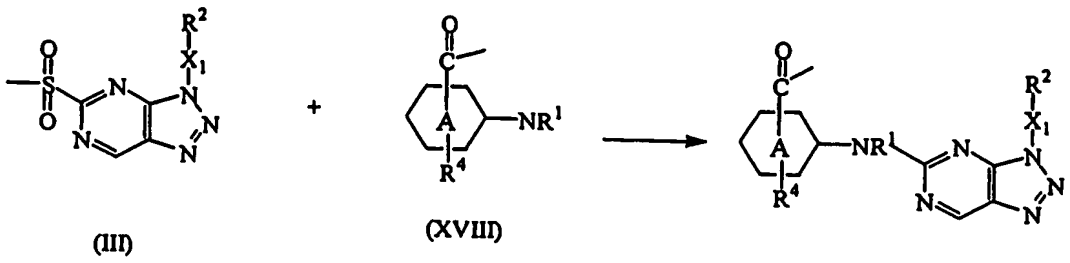
(VIII) (XIV)

Intermediates of formula (XV) can be prepared by reacting an intermediate of formula (XVII) with *N,N*-dimethylformamide (DMF) in the presence of a suitable base, such as for example diethylamine.



(XVII) (XV)

Intermediates of formula (XVII) can be prepared by reacting an intermediate of formula (III) with an intermediate of formula (XVIII) in the presence of a suitable solvent, such as for example dimethylsulfoxide, $CH_3\text{-}O\text{-}CH_2\text{-}CH_2\text{-}OH$ or $(CH_3)_2N\text{-}C(=O)H$ in the presence of NaH.



(III) (XVIII) (XVII)

The compounds of formula (I) inhibit Glycogen synthase kinase 3 (GSK3), in particular glycogen synthase kinase 3 alpha (GSK3α) and/or glycogen synthase kinase 3 beta (GSK3β). They are selective Glycogen synthase kinase 3 inhibitors. Specific inhibitory compounds are superior therapeutic agents since they are characterized by a greater efficacy and lower toxicity by virtue of their specificity.
Synonyms for GSK3 are tau protein kinase I (TPK I), FA (Factor A) kinase, kinase FA and ATP-citrate lysase kinase (ACLK).

Glycogen synthase kinase 3 (GSK3), which exists in two isoforms as already stated above, i.e. GSK3α and GSK3β, is a proline-directed serine/threonine kinase originally identified as an enzyme that phosphorylates glycogen synthase. However, it has been demonstrated that GSK3 phosphorylates numerous proteins in vitro such as glycogen synthase, phosphatase inhibitor I-2, the type-II subunit of cAMP-dependent protein kinase, the G-subunit of phosphatase-1, ATP-citrate lyase, acetyl coenzyme A carboxylase, myelin basic protein, a microtubule-associated protein, a neurofilament protein, an N-CAM cell adhesion molecule, nerve growth factor receptor, c-Jun transcription factor, JunD transcription factor, c-Myb transcription factor, c-Myc transcription factor, L-Myc transcription factor, adenomatous polyposis coli tumor supressor protein, tau protein and β-catenin.

The above-indicated diversity of proteins which may be phosphorylated by GSK3 implies that GSK3 is implicated in numerous metabolic and regulatory processes in cells.

GSK3 inhibitors may therefore be useful in the prevention or treatment of diseases mediated through GSK3 activity such as bipolar disorder (in particular manic depression), diabetes, Alzheimer's disease, leukopenia, FTDP-17 (Fronto-temporal dementia associated with Parkinson's disease), cortico-basal degeneration, progressive supranuclear palsy, multiple system atrophy, Pick's disease, Niemann Pick's disease type C, Dementia Pugilistica, dementia with tangles only, dementia with tangles and calcification, Down syndrome, myotonic dystrophy, Parkinsonism-dementia complex

of Guam, aids related dementia, Postencephalic Parkinsonism, prion diseases with tangles, subacute sclerosing panencephalitis, frontal lobe degeneration (FLD), argyrophilic grains disease, subacute sclerotizing panencephalitis (SSPE) (late complication of viral infections in the central nervous system), inflammatory diseases, cancer, dermatological disorders such as baldness, neuroprotection, schizophrenia, pain, in particular neuropathic pain. GSK3 inhibitors can also be used to inhibit sperm motility and can therefore be used as male contraceptives.
In particular, the compounds of the present invention are useful in the prevention or treatment of Alzheimer's disease, diabetes, especially type 2 diabetes (non insulin dependent diabetes).

The major neuropathological landmarks in Alzheimer's disease are neuronal loss, the deposition of amyloid fibers and paired helical filaments (PHF) or neurofibrillary tangles (NFT). Tangle formation appears to be the consequence of accumulation of aberrantly phosphorylated tau protein. This aberrant phosphorylation destabilizes neuronal cytoskeleton, which leads to reduced axonal transport, deficient functioning and ultimately neuronal death. The density of neurofibrillary tangles has been shown to parallel duration and severity of Alzheimer's disease. Reduction of the degree of tau phosphorylation can provide for neuroprotection and can prevent or treat Alzheimer's disease or can slow the progression of the disease. As mentioned hereinabove, GSK3 phosphorylates tau protein. Thus compounds having an inhibitory activity for GSK3 may be useful for the prevention or the treatment of Alzheimer's disease.

Insulin regulates the synthesis of the storage polysaccharide glycogen. The rate-limiting step in the glycogen synthesis is catalyzed by the enzyme glycogen synthase. It is believed that glycogen synthase is inhibited by phosphorylation and that insulin stimulates glycogen synthase by causing a net decrease in the phosphorylation of this enzyme. Thus, in order to activate glycogen synthase, insulin must either activate phosphatases or inhibit kinases, or both.
It is believed that glycogen synthase is a substrate for glycogen synthase kinase 3 and that insulin inactivates GSK3 thereby promoting the dephosphorylation of glycogen synthase.
In addition to the role of GSK3 in insulin-induced glycogen synthesis, GSK3 may also play a role in insulin resistance. It is believed that GSK3 dependent Insulin Receptor Substrate-1 phosphorylation contributes to insulin resistance.
Therefore, GSK3 inhibition may result in the increased deposition of glycogen and a concomitant reduction of blood glucose, thus mimicing the hypoglycemic effect of

insulin. GSK3 inhibition provides an alternative therapy to manage insulin resistance commonly observed in non insulin dependent diabetes mellitus and obesity. GSK3 inhibitors may thus provide a novel modality for the treatment of type 1 and type 2 diabetes.

GSK3 inhibitors may also be indicated for use in the prevention or the treatment of pain, in particular neuropathic pain.
After axotomy or chronic constriction injury, neuronal cells die through an apoptotic pathway and the morphological changes correlate with the onset of hyperalgesia and/or allodynia.
The induction of apoptosis is probably triggered by a reduced supply of neurotrophic factors as the time course of neuronal loss is positively altered by administration of neurotrophins. GSK3 has been shown to be involved in the initiation of the apoptotic cascade and trophic factor withdrawal stimulates the GSK3 apoptosis pathway.
In view of the above, GSK3 inhibitors might reduce signals of and even prevent levels of neuropathic pain.

Due to their GSK3 inhibitory properties, the compounds of formula (I), their *N*-oxides, pharmaceutically acceptable addition salts, quaternary amines and stereochemically isomeric forms thereof, are useful to prevent or treat GSK3 mediated diseases, such as bipolar disorder (in particular manic depression), diabetes, Alzheimer's disease, leukopenia, FTDP-17 (Fronto-temporal dementia associated with Parkinson's disease), cortico-basal degeneration, progressive supranuclear palsy, multiple system atrophy, Pick's disease, Niemann Pick's disease type C, Dementia Pugilistica, dementia with tangles only, dementia with tangles and calcification, Down syndrome, myotonic dystrophy, Parkinsonism-dementia complex of Guam, aids related dementia, Postencephalic Parkinsonism, prion diseases with tangles, subacute sclerosing panencephalitis, frontal lobe degeneration (FLD), argyrophilic grains disease, subacute sclerotizing panencephalitis (SSPE) (late complication of viral infections in the central nervous system), inflammatory diseases, cancer, dermatological disorders such as baldness, neuroprotection, schizophrenia, pain, in particular neuropathic pain. The present compounds are also useful as male contraceptives. In general, the compounds of the present invention may be useful in the treatment of warm-blooded animals suffering from disease mediated through GSK3, in particular GSK3β, or they may be useful to prevent warm-blooded animals to suffer from disease mediated through GSK3, in particular GSK3β. More in particular, the compounds of the present invention may be useful in the treatment of warm-blooded animals suffering from

Alzheimer's disease, diabetes, especially type 2 diabetes, cancer, inflammatory diseases or bipolar disorder.

In view of the above described pharmacological properties, the compounds of formula (I) or any subgroup thereof, their N-oxides, pharmaceutically acceptable addition salts, quaternary amines and stereochemically isomeric forms, may be used as a medicine. In particular, the present compounds can be used for the manufacture of a medicament for treating or preventing diseases mediated through GSK3. More in particular, the present compounds can be used for the manufacture of a medicament for treating or preventing Alzheimer's disease, diabetes, especially type 2 diabetes, cancer, inflammatory diseases or bipolar disorder.

In view of the utility of the compounds of formula (I), there is provided a method of treating warm-blooded animals, including humans, suffering from or a method of preventing warm-blooded animals, including humans, to suffer from diseases mediated through GSK3, more in particular a method of treating or preventing Alzheimer's disease, diabetes, especially type 2 diabetes, cancer, inflammatory diseases or bipolar disorder. Said method comprises the administration, preferably oral administration, of an effective amount of a compound of formula (I), a *N*-oxide form, a pharmaceutically acceptable addition salt, a quaternary amine or a possible stereoisomeric form thereof, to warm-blooded animals, including humans.

The present invention also provides compositions for preventing or treating diseases mediated through GSK3, comprising a therapeutically effective amount of a compound of formula (I) and a pharmaceutically acceptable carrier or diluent.

The compounds of the present invention or any subgroup thereof may be formulated into various pharmaceutical forms for administration purposes. As appropriate compositions there may be cited all compositions usually employed for systemically administering drugs. To prepare the pharmaceutical compositions of this invention, an effective amount of the particular compound, optionally in addition salt form, as the active ingredient is combined in intimate admixture with a pharmaceutically acceptable carrier, which carrier may take a wide variety of forms depending on the form of preparation desired for administration. These pharmaceutical compositions are desirable in unitary dosage form suitable, particularly, for administration orally, rectally, percutaneously, or by parenteral injection. For example, in preparing the compositions in oral dosage form, any of the usual pharmaceutical media may be

employed such as, for example, water, glycols, oils, alcohols and the like in the case of oral liquid preparations such as suspensions, syrups, elixirs, emulsions and solutions; or solid carriers such as starches, sugars, kaolin, diluents, lubricants, binders, disintegrating agents and the like in the case of powders, pills, capsules, and tablets. Because of their ease in administration, tablets and capsules represent the most advantageous oral dosage unit forms, in which case solid pharmaceutical carriers are obviously employed. For parenteral compositions, the carrier will usually comprise sterile water, at least in large part, though other ingredients, for example, to aid solubility, may be included. Injectable solutions, for example, may be prepared in which the carrier comprises saline solution, glucose solution or a mixture of saline and glucose solution. Injectable suspensions may also be prepared in which case appropriate liquid carriers, suspending agents and the like may be employed. Also included are solid form preparations which are intended to be converted, shortly before use, to liquid form preparations. In the compositions suitable for percutaneous administration, the carrier optionally comprises a penetration enhancing agent and/or a suitable wetting agent, optionally combined with suitable additives of any nature in minor proportions, which additives do not introduce a significant deleterious effect on the skin. Said additives may facilitate the administration to the skin and/or may be helpful for preparing the desired compositions. These compositions may be administered in various ways, e.g., as a transdermal patch, as a spot-on, as an ointment. The compounds of the present invention may also be administered via inhalation or insufflation by means of methods and formulations employed in the art for administration via this way. Thus, in general the compounds of the present invention may be administered to the lungs in the form of a solution, a suspension or a dry powder. Any system developed for the delivery of solutions, suspensions or dry powders via oral or nasal inhalation or insufflation are suitable for the administration of the present compounds.

It is especially advantageous to formulate the aforementioned pharmaceutical compositions in unit dosage form for ease of administration and uniformity of dosage. Unit dosage form as used herein refers to physically discrete units suitable as unitary dosages, each unit containing a predetermined quantity of active ingredient calculated to produce the desired therapeutic effect in association with the required pharmaceutical carrier. Examples of such unit dosage forms are tablets (including scored or coated tablets), capsules, pills, powder packets, wafers, suppositories, injectable solutions or suspensions and the like, and segregated multiples thereof.

The present compounds are orally active compounds, and are preferably orally administered.

The exact dosage, the therapeutically effective amount and frequency of administration depends on the particular compound of formula (I) used, the particular condition being treated, the severity of the condition being treated, the age, weight, sex, extent of disorder and general physical condition of the particular patient as well as other medication the individual may be taking, as is well known to those skilled in the art. Furthermore, it is evident that said effective daily amount may be lowered or increased depending on the response of the treated subject and/or depending on the evaluation of the physician prescribing the compounds of the instant invention.

When used as a medicament to prevent or treat Alzheimer's disease, the compounds of formula (I) may be used in combination with other conventional drugs used to combat Alzheimer's disease, such as galantamine, donepezil, rivastigmine or tacrine.

Thus, the present invention also relates to the combination of a compound of formula (I) and another agent capable of preventing or treating Alzheimer's disease. Said combination may be used as a medicine. The present invention also relates to a product containing (a) a compound of formula (I), and (b) another agent capable of preventing or treating Alzheimer's disease, as a combined preparation for simultaneous, separate or sequential use in the prevention or treatment of Alzheimer's disease. The different drugs may be combined in a single preparation together with pharmaceutically acceptable carriers.

When used as a medicament to prevent or treat type 2 diabetes, the compounds of formula (I) may be used in combination with other conventional drugs used to combat type 2 diabetes, such as glibenclamide, chlorpropamide, gliclazide, glipizide, gliquidon, tolbutamide, metformin, acarbose, miglitol, nateglinide, repaglinide, acetohexamide, glimepiride, glyburide, tolazamide, troglitazone, rosiglitazone, pioglitazone, isaglitazone.

Thus, the present invention also relates to the combination of a compound of formula (I) and another agent capable of preventing or treating type 2 diabetes. Said combination may be used as a medicine. The present invention also relates to a product containing (a) a compound of formula (I), and (b) another agent capable of preventing or treating type 2 diabetes, as a combined preparation for simultaneous, separate or sequential use in the prevention or treatment of type 2 diabetes. The different drugs may be combined in a single preparation together with pharmaceutically acceptable carriers.

When used as a medicament to prevent or treat cancer, the compounds of formula (I) may be used in combination with other conventional drugs used to combat cancer such as platinum coordination compounds for example cisplatin or carboplatin; taxane compounds for example paclitaxel or docetaxel; camptothecin compounds for example irinotecan or topotecan; anti-tumour vinca alkaloids for example vinblastine, vincristine or vinorelbine; anti-tumour nucleoside derivatives for example 5-fluorouracil, gemcitabine or capecitabine; nitrogen mustard or nitrosourea alkylating agents for example cyclophosphamide, chlorambucil, carmustine or lomustine; anti-tumour anthracycline derivatives for example daunorubicin, doxorubicin or idarubicin; HER2 antibodies for example trastzumab; and anti-tumour podophyllotoxin derivatives for example etoposide or teniposide; and antiestrogen agents including estrogen receptor antagonists or selective estrogen receptor modulators preferably tamoxifen, or alternatively toremifene, droloxifene, faslodex and raloxifene; aromatase inhibitors such as exemestane, anastrozole, letrazole and vorozole; differentiating agents for example retinoids, vitamin D and DNA methyl transferase inhibitors for example azacytidine; kinase inhibitors for example flavoperidol and imatinib mesylate or farnesyltransferase inhibitors for example R115777.

Thus, the present invention also relates to the combination of a compound of formula (I) and another agent capable of preventing or treating cancer. Said combination may be used as a medicine. The present invention also relates to a product containing (a) a compound of formula (I), and (b) another agent capable of preventing or treating cancer, as a combined preparation for simultaneous, separate or sequential use in the prevention or treatment of cancer. The different drugs may be combined in a single preparation together with pharmaceutically acceptable carriers.

When used as a medicament to prevent or treat bipolar disorder, the compounds of formula (I) may be used in combination with other conventional drugs used to combat bipolar disorder such as atypical antipsychotics, anti-epileptica, benzodiazepines, lithium salts, for example olanzapine, risperidone, carbamazepine, valproate, topiramate.

Thus, the present invention also relates to the combination of a compound of formula (I) and another agent capable of preventing or treating bipolar disorder. Said combination may be used as a medicine. The present invention also relates to a product containing (a) a compound of formula (I), and (b) another agent capable of preventing or treating bipolar disorder, as a combined preparation for simultaneous, separate or sequential use in the prevention or treatment of bipolar disorder. The different drugs

may be combined in a single preparation together with pharmaceutically acceptable carriers.

When used as a medicament to prevent or treat inflammatory diseases, the compounds of formula (I) may be used in combination with other conventional drugs used to combat inflammatory diseases such as steroids, cyclooxygenase-2 inhibitors, non-steroidal-anti-inflammatory drugs, TNF- α antibodies, such as for example acetyl salicylic acid, bufexamac, diclofenac potassium, sulindac, diclofenac sodium, ketorolac trometamol, tolmetine, ibuprofen, naproxen, naproxen sodium, tiaprofen acid, flurbiprofen, mefenamic acid, nifluminic acid, meclofenamate, indomethacin, proglumetacine, ketoprofen, nabumetone, paracetamol, piroxicam, tenoxicam, nimesulide, fenylbutazon, tramadol, beclomethasone dipropionate, betamethasone, beclamethasone, budesonide, fluticasone, mometasone, dexamethasone, hydrocortisone, methylprednisolone, prednisolone, prednisone, triamcinolone, celecoxib, rofecoxib, infliximab, leflunomide, etanercept, CPH 82, methotrexate, sulfasalazine.

Thus, the present invention also relates to the combination of a compound of formula (I) and another agent capable of preventing or treating inflammatory diseases. Said combination may be used as a medicine. The present invention also relates to a product containing (a) a compound of formula (I), and (b) another agent capable of preventing or treating inflammatory diseases, as a combined preparation for simultaneous, separate or sequential use in the prevention or treatment of inflammatory disorders. The different drugs may be combined in a single preparation together with pharmaceutically acceptable carriers.

The following examples illustrate the present invention.

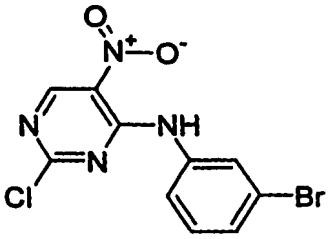
Experimental part

Hereinafter, "DMF" is defined as *N,N*-dimethylformamide, "DIPE" is defined as diisopropylether, "DMSO" is defined as dimethylsulfoxide, "THF" is defined as tetrahydrofuran, "DMA" is defined as *N,N*-dimethylacetamide and "DIPEA" is defined as diisopropylethylamine.

A. Preparation of the intermediate compounds

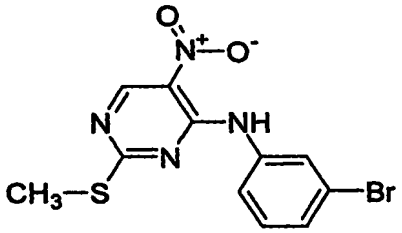
Example A1

a. Preparation of intermediate 1



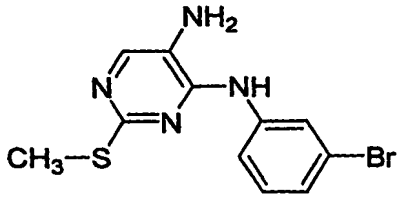
A mixture of 2,4-dichloro-5-nitropyrimidine (0.05 mol) in DMA (400 ml) was cooled to -20 °C and *N*-ethyl-*N*-(1-methylethyl)-2-propanamine (0.05 mol) was added, then a mixture of 3-bromo-benzeneamine (0.05 mol) in DMA (200 ml) was added dropwise at -20 °C and the reaction mixture was stirred at -20 °C for 2 hours. The reaction mixture was used as such in the next reaction step.

b. Preparation of intermediate 2



$NaSCH_3$, 21% in H_2O (0.05 mol) was added dropwise to intermediate 1 (0.05 mol) and the reaction mixture was stirred for 1.5 hour at room temperature, then the mixture was carefully poured out into H_2O. The resulting precipitate was stirred over the weekend, filtered off, washed and dried (vac.), yielding 15.73 g (92.5 %). The product was crystallised from CH_3CN, then the resulting precipitate was filtered off, washed and dried (vac.), yielding intermediate 2.

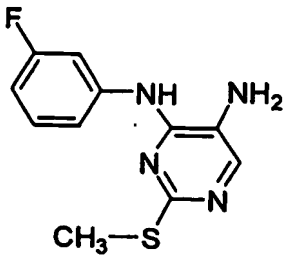
c. Preparation of intermediate 3

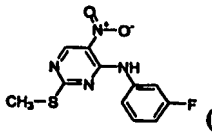


A mixture of intermediate 2 (0.028 mol) in CH_3OH (250 ml) was hydrogenated with Pt/C 5% (2g) as a catalyst in the presence of a solution of thiophene in DIPE (4%, 1 ml). After uptake of H_2 (3 equiv.), the catalyst was filtered off and the filtrate was evaporated. The residue was crystallised from CH_3CN, then the resulting precipitate was filtered off, washed and dried (vac.). Yield: 5.2 g of intermediate 3

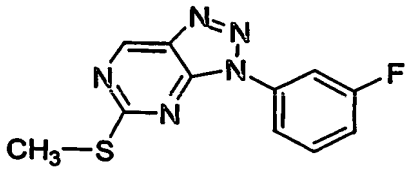
Example A2

a. Preparation of intermediate 4



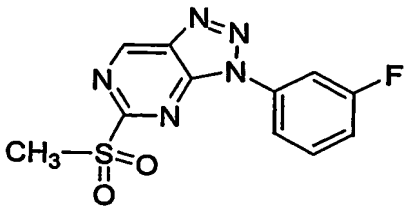
A mixture of  (prepared according to A1.b) (0.07 mol) and Et_3N (10 g) in THF (250 ml) was hydrogenated with Pd/C, 10% (5 g) as a catalyst in the presence of a solution of thiophene in DIPE (4%, 5 ml). After uptake of H_2 (3 equiv), the catalyst was filtered off and the filtrate was evaporated. The residue was stirred in DIPE with a small amount of CH_3CN. The precipitate was filtered off and dried. Yield: 12.3 g of intermediate 4 (70.2%). The filtrate was acidified with HCl/2-propanol while stirring. The mixture was stirred for 30 minutes. The resulting precipitate was filtered off and dried. Yield: 5.17 g of intermediate 4 (25.7%).

b. Preparation of intermediate 5



Intermediate 4 (0.08 mol) was dissolved in a mixture of 6N HCl (400 ml) and HOAc, p.a. (400 ml) and the whole was cooled to 0-5 °C. A solution of $NaNO_2$ (0.1 mol) in H_2O (40 ml) was added dropwise over a 30 minutes period. Then, the reaction mixture was stirred for another 30 minutes while cooling on the ice-bath. Then, the mixture was stirred overnight at room temperature. The resulting precipitate was filtered off, rinsed with water, with 2-propanone, then with DIPE, and dried. Yield: 18.14 g of intermediate 5 (87%).

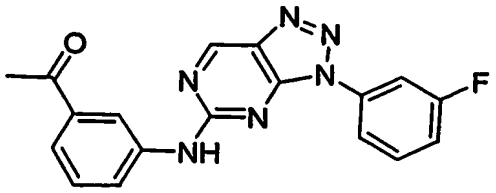
c. Preparation of intermediate 6



Intermediate 5 (15 g, 0.058 mol) was stirred in HOAc (700 ml) and cooled on an ice-bath. A solution of $KMnO_4$, p.a. (24 g, 0.15 mol) in demineralized H_2O, (300 ml) was added dropwise over a 60 minutes period while cooling on an ice-bath. The mixture

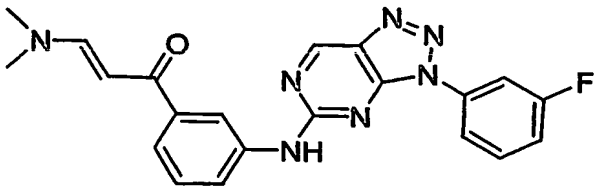
was stirred for one hour on the ice-bath, then for 2 hours at room temperature. Sodium bisulfite was added until a colour change resulted. EtOAc (same quantity) was added while stirring vigorously for a while. The mixture was stood overnight. The mixture was concentrated to ~ 50-ml volume. The aqueous concentrate was stirred for a while and the resulting precipitate was filtered off and dried. Yield: 11.023 g of intermediate 6 (64.8%).

d. Preparation of intermediate 6a



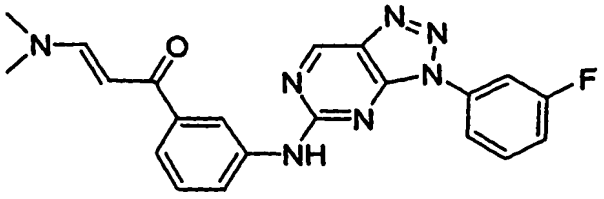
A mixture of intermediate 6 (0.001 mol) and 1-(3-aminophenyl)ethanone (0.002 mol) in 2-methoxyethanol (10 ml) was stirred and refluxed for 16 hours and the solution was cooled. The resulting precipitate was filtered off, rinsed with EtOH/DIPE and dried. Yield: 0.250 g intermediate 6a (72 %, m.p. 220-224°C). The filtrate was evaporated and the residue was stirred in CH_3CN/CH_3OH (2ml/2ml). The mixture was stirred for a while, then the precipitate was filtered off and dried. Yield: 0.098 g of intermediate 6a (28%).

e-1. Preparation of intermediate 6b

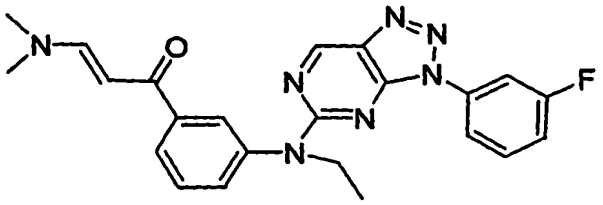


DMF/DMA (0.00675 mol, 5 equiv.) was added to a suspension of intermediate 6a (0.00135 mol, 1 equiv.) in DMF (3ml) and the reaction mixture was heated at 115°C for 2 hours, then stirred overnight at room temperature. The resulting precipitate was filtered off and the residue was triturated under diethyl ether on the funnel. Yield : 0.38 g of intermediate 6b (70 %; 240-244°C).

e-2. Preparation of intermediate 6b and intermediate 6c



Intermediate 6b

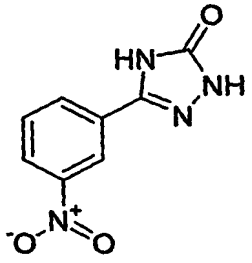


Intermediate 6c

A mixture of intermediate 6a (0.0056 mol, 1 equiv.) in neat DMF/diethylamine (6 ml) was heated overnight at 110-120°C, then EtOH was distilled off and extra DMF/diethylamine (2 ml) was added. The resulting suspension was heated at 120-130°C for 5 hours, then DMF (2 ml) and extra DMF/diethylamine (1 ml) were added. The reaction mixture was heated at 140°C for 2 hours, extra DMF (1 ml) was added and the heating was continued. The resulting solution was stirred and refluxed for 1 hour and then stirred overnight at room temperature. The obtained precipitate was filtered off and triturated on the funnel with Et_2O and hexane. Yield 0.38 g of intermediate 6b (17 %, m.p.: 235-236°C). The mother layer was concentrated and the residue was collected. Yield : 1.12 g of intermediate 6c (50 %, m.p. 176-179°C).

Example A3

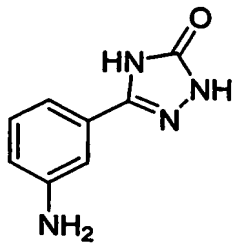
a. Preparation of intermediate 7



3-Nitrobenzonitrile (0.12 mol) was suspended in EtOH, p.a. (250 ml). NaOEt (0.1 g) was added in one portion and the reaction mixture was stirred overnight. Hydrazinecarboxylic acid methyl ester (0.36 mol) was added in one portion and the reaction mixture was stirred and refluxed overnight. The reaction mixture was

concentrated and redissolved in DMF (150 ml) and heated at 140°C over the weekend. The reaction mixture was concentrated (vacuum) and the residue was suspended in H_2O (500 ml) and filtered. The resulting residue was again suspended in H_2O/EtOH (±2000 ml) and this suspension was heated at refluxed overnight. The hot solution was filtered into an ice-cold erlenmeyer and the solution was stirred for 2 hours. The precipitate was filtered and dried in a vacuum oven (60°C). Yield : 11.84g of intermediate 7 (45.9%).

b. Preparation of intermediate 8

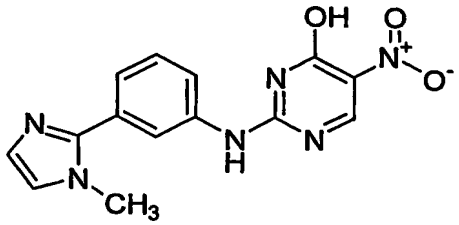


A mixture of intermediate 7 (10 g; 0.048 mol) in MeOH (150 ml) and THF (100 ml) was hydrogenated at 50°C with Pd/C 10% (1 g) as a catalyst in the presence of a solution of thiophene in DIPE (4%, 1 ml). After uptake of H_2 (3 equiv.), the catalyst was filtered off and the filtrate was concentrated. This fraction was suspended in acetone, filtered and dried (vacuum 60°C). Yield : 7.06g of intermediate 8 (83.5%).

4-(3-amino-phenyl)-pyrimidin-2-ylamine was prepared in an analogous manner : A solution of 4-(3-nitro-phenyl)-pyrimidin-2-ylamine (0.046 mol) in MeOH (250 ml) was hydrogenated at 50°C with Pd/C 10% (2 g) as a catalyst in the presence of a solution of thiophene in DIPE (4% v/v, 1 ml). After uptake of H_2 (3 equiv.), the catalyst was filtered off and the filtrate was concentrated and dried (vacuum 60°C). Yield : 8.64g of 4-(3-amino-phenyl)-pyrimidin-2-ylamine (87%) (m.p. ; 190-194°C).

Example A4

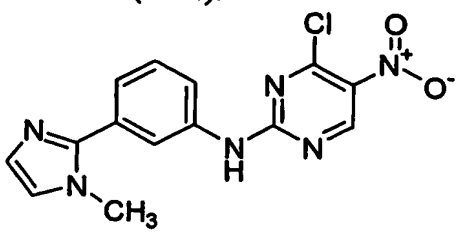
a. Preparation of intermediate 9



A mixture of 2-chloro-5-nitro-4(1*H*)-pyrimidinone sodium salt (0.051 mol), 3-(1-methyl-1*H*-imidazol-2-yl)benzenamine (0.056 mol) and *N*-ethyl-*N*-(1-methylethyl)-2-propanamine (0.168 mol) in H_2O (200 ml) and THF (100 ml) was

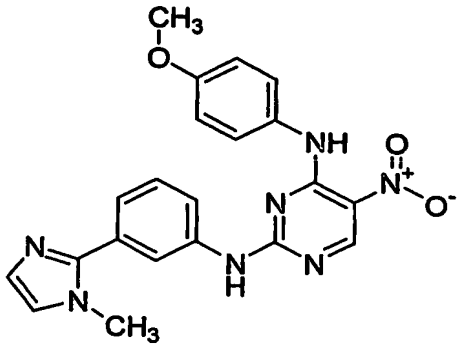
stirred and refluxed for 1 day, then the reaction mixture was cooled to room temperature and the solvent was evaporated under reduced pressure. The residue was stirred in CH_3OH and the resulting precipitate was filtered off, washed with CH_3OH and then dried (vac.). Yield: 13.6 g of intermediate 9 (85 %).

b. Preparation of intermediate 10



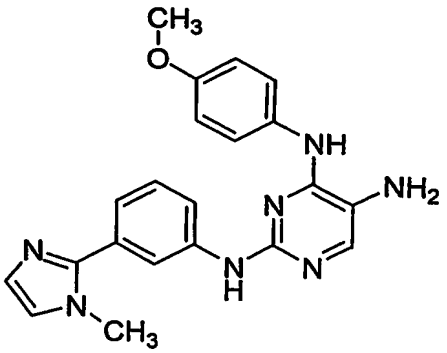
A suspension of intermediate 9 (0.0256 mol) in 6N HCl/2-propanol was stirred at room temperature for 1 hour and then the solvent was evaporated under reduced pressure. $POCl_3$ (100 ml) was added to the residue and the reaction mixture was stirred and refluxed for 1 hour, then stirred at room temperature for 1 hour. The solvent was evaporated under reduced pressure and then co-evaporated with toluene. Quantitative Yield of intermediate 10.

c. Preparation of intermediate 11



A mixture of intermediate 10 (0.000502 mol), 4-methoxybenzenamine (0.000624 mol) and *N*-ethyl-*N*-(1-methylethyl)-2-propanamine (0.000624 mol) in DMA (5 ml) was stirred at 100 °C for 1 hour and the reaction mixture was used as such in the next reaction step.

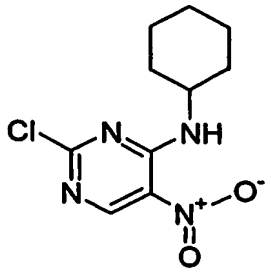
d. Preparation of intermediate 12



A mixture of intermediate 11 (0.000502 mol) in DMA (q.s.) was hydrogenated overnight with Pt/C (cat.quant.) as a catalyst. After uptake of H_2 (3 equiv.), the catalyst was filtered off and the filtrate was evaporated. Yield: intermediate 12.

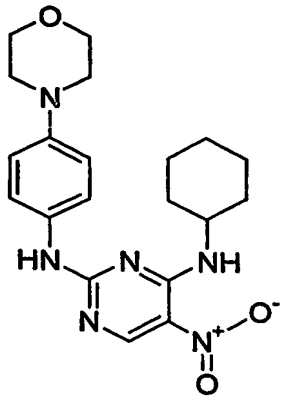
Example A5

a. Preparation of intermediate 13



A solution of cyclohexanamine (0.062 mol) in DMA (20 ml) was added dropwise to a cooled (-10 °C) solution of 2,4-dichloro-5-nitropyrimidine (0.062 mol) and *N*-ethyl-*N*-(1-methylethyl)-2-propanamine (8.1 g) in DMA (80 ml), then the reaction mixture was allowed to reach room temperature overnight. Yield: intermediate 13 used as such in the next reaction step.

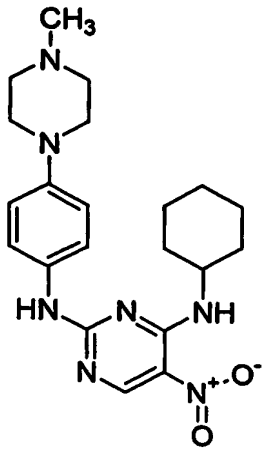
b. Preparation of intermediate 14



N-ethyl-*N*-(1-methylethyl)-2-propanamine (0.027 mol) was added to intermediate 13 (0.0257), giving mixture (I). A mixture of 4-(4-morpholinyl)benzenamine (0.0257 mol) in DMA (25 ml, p.a.) was added dropwise at 80 °C to mixture (I) and the reaction mixture was stirred overnight, then poured out into ice-water (500 ml). The resulting solids were filtered off and dried in a vacuum oven at 75 °C. This fraction was heated at reflux temperature in 2-propanol/2-propanol (6N HCl) and cooled, then the product was filtered off and dried. Yield: 9.6 g of intermediate 14.

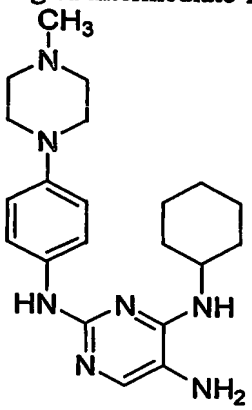
Example A6

a. Preparation of intermediate 15



A mixture of intermediate 13 (prepared according to A5.a) (0.031 mol), 4-(4-methyl-1-piperazinyl)benzenamine hydrochloride (0.031 mol) and *N*-ethyl-*N*-(1-methylethyl)-2-propanamine (10 g) was heated at 60 °C for 3 hours, then the reaction mixture was cooled and added dropwise to H_2O (200 ml). The resulting solids were filtered off and dried in a vacuum oven at 60 °C. Yield: 9.6 g of intermediate 15.

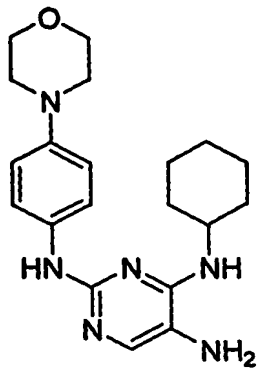
b. Preparation of intermediate 16



A mixture of intermediate 15 (0.023 mol) and Et_3N (10 ml) in THF (250 ml) was hydrogenated at 50 °C with Pd/C 10% (2 g) as a catalyst in the presence of a solution of thiophene in DIPE (4%, 1 ml). After uptake of H_2 (3 equiv.), the catalyst was filtered off and the filtrate was evaporated. The residue was dissolved in CH_2Cl_2, washed with H_2O and dried. Yield: 6.7 g of intermediate 16 (76.5 %).

Example A7

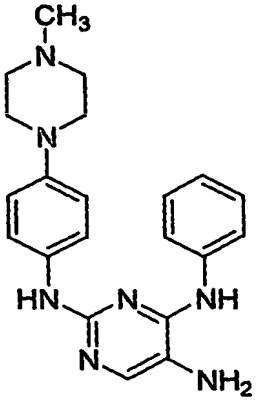
Preparation of intermediate 17

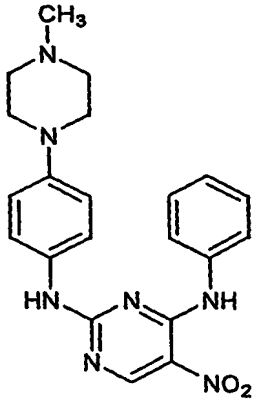


A mixture of intermediate 14 (prepared according to A5.b) (0.024 mol) in CH_3OH (250 ml) was hydrogenated with Pt/C 5% (2 g) as a catalyst in the presence of a solution of thiophene in DIPE (4%, 1 ml). After uptake of H_2 (3 equiv.), the catalyst was filtered off and the filtrate was evaporated. Yield: 8.7 g intermediate 17.

Example A8

Preparation of intermediate 18



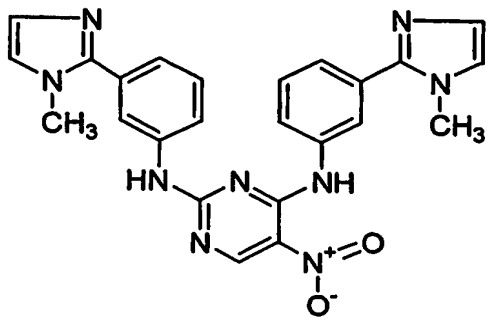


A mixture of intermediate (prepared according to A6.a) (0.007 mol) in THF (150 ml) was hydrogenated at 50 °C with Pd/C 10% (1 g) as a catalyst in the presence of a solution of thiophene in DIPE (4%, 1 ml). After uptake of H_2 (3

equiv.), the catalyst was filtered off and the filtrate was evaporated. 2-propanol/HCl (6N) was added to the residue and the mixture was stirred for 1 hour. The resulting precipitate was filtered off and dried in a vacuum oven at 60 °C. Yield: 3 g of intermediate 18.

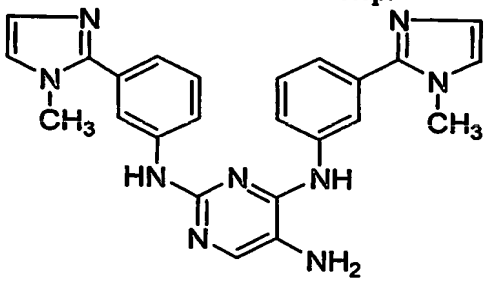
Example A9

a. Preparation of intermediate 19



A mixture of 2,4-dichloro-5-nitropyrimidine (0.0127 mol), 3-(1-methyl-1*H*-imidazol-2-yl)benzenamine (0.0254 mol) and DIPEA (0.0254 mol) in DMF (60ml) was stirred overnight at 60°C. The reaction mixture was used as such in the next step.

b. Preparation of intermediate 20

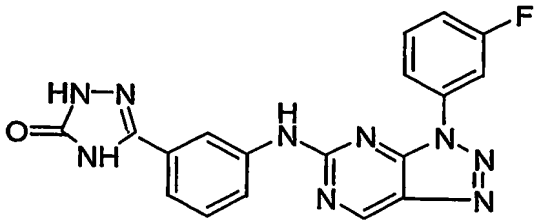


Intermediate 19 (0.0127 mol) in DMF (100ml) was hydrogenated at room temperature with Pd/C 10% (2g) as a catalyst in the presence of a solution of thiophene in DIPE (4%, 2 ml). After uptake of H_2 (3 equiv), the catalyst was filtered off and the solvent was evaporated. Yield : intermediate 20. This fraction was used as such in further step.

B. Preparation of the final compounds

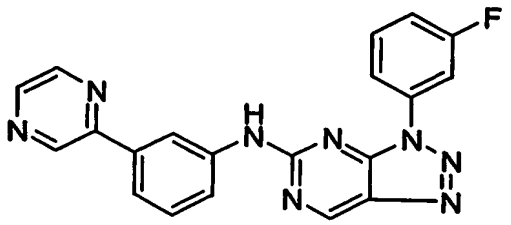
Example B1

a. Preparation of compound 1



A mixture of intermediate 6 (prepared according to A2.c) (0.0002 mol) and (prepared according to A3.b) (0.0004 mol) in DMSO, p.a. (1 ml) was stirred for 2 hours at 100°C, the reaction mixture was diluted with CH_3CN (1 ml) and stirred overnight. The resulting precipitate was filtered off and dried. Yield: 0.061 g of compound 1 (78%, m.p.: > 260 °C).

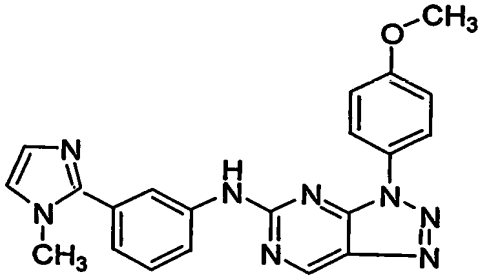
b. Preparation of compound 2



A mixture of intermediate 6 (prepared according to A2.c) (0.0005 mol) and 3-pyrazin-2-ylbenzenamine (0.0005 mol) in 2-methoxyethanol (4 ml) was stirred at 100°C for 30 minutes, then the reaction mixture was allowed to reach room temperature. The resulting precipitate was filtered off and dried. Yield: 0.082 g of compound 2 (m.p.: > 260 °C).

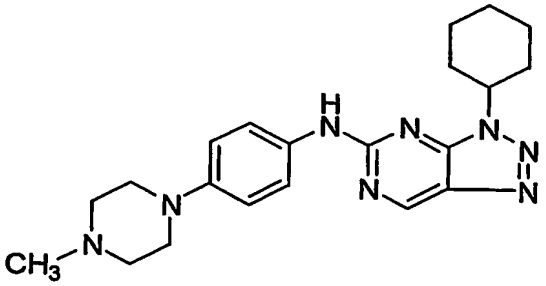
Example B2

a. Preparation of compound 3



A mixture of intermediate 12 (prepared according to A4.d) (0.000502 mol, H_2O and HCl (6N) was stirred at 0°C for 20 minutes, then $NaNO_2$ was added in one portion and the reaction mixture was stirred at room temperature for 48 hours. Yield: compound 3.

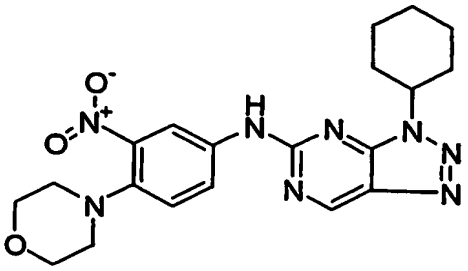
b. Preparation of compound 4



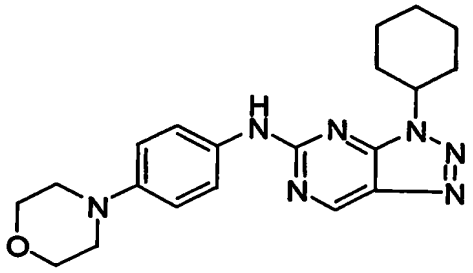
A mixture of $NaNO_2$ (0.00797 mol) in H_2O (q.s.) was added dropwise to an ice cooled mixture of intermediate 16 (prepared according to A6.b) (0.00786 mol) in HCl, 6N (30

ml) and H_2O (q.s.) and the reaction mixture was allowed to reach room temperature, then the mixture was poured out into a saturated $NaHCO_3$ solution and extracted with CH_2Cl_2 (3 times 200 ml). The organic layers were combined, dried ($MgSO_4$) and the solvent was evaporated. The residue was purified by reversed phase chromatography, then the product fractions were collected and the solvent was evaporated. Yield: 0.733 g of compound 4 (24 %, m.p.: 167°C).

c. Preparation of compound 5 and 6



compound 5

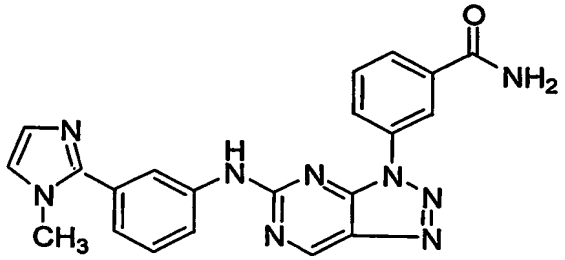


compound 6

A solution of intermediate 17 (prepared according to A7) (0.0038 mol) in H_2O (100 ml) and HCl, concentrated (5 ml) was cooled and a mixture of $NaNO_2$ (0.0038 mol) in H_2O (5 ml) was slowly added dropwise, then the reaction mixture was stirred overnight at room temperature and CH_2Cl_2 (75 ml) was added. The pH of the aqueous layer was adjusted to pH 9 and extracted with CH_2Cl_2 (3 times 75 ml). The organic layers were combined, dried ($MgSO_4$), filtered off and the solvent was evaporated (vacuum). The residue was purified by reversed phase chromatography, then two product fractions were collected and the solvent was evaporated. Yield fraction 1: 0.100 g of compound 5 (m.p.: 161.9 °C). Yield fraction 2: 0.0106 g of compound 6.

Example B3

Preparation of compound 7

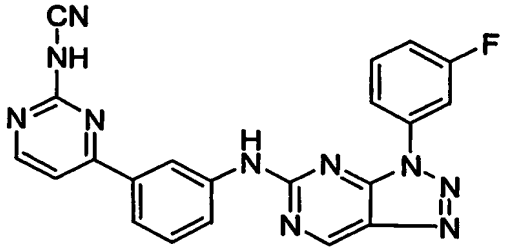


A solution of intermediate 20 (prepared according to A9.b) (0.0127 mol) in CH_3COOH (30 ml) and 6N HCl (50 ml) was stirred at 0°C. A solution of $NaNO_2$ (0.015 mol) in H_2O (10 ml) was added dropwise and the resulting reaction mixture was stirred for one hour at 0 °C, then overnight at room temperature. The solvent was evaporated under reduced pressure. The residue was purified by HPLC over Hyperprep C18 (HS, BDS,

100 Å, 8 µm, Shandon; eluent: [(0.5% NH_4OAc in H_2O)/CH_3CN 90/10 vol%]/CH_3OH/CH_3CN (0 minutes) 75/25/0, (24 minutes) 38/37/25, (24.01-32 minutes) 0/0/100). The product fractions were collected and the solvent was evaporated. The residue was stirred in DIPE, filtered off, washed and dried (vacuum, 50 °C). Yield: 0.160 g of compound 7.

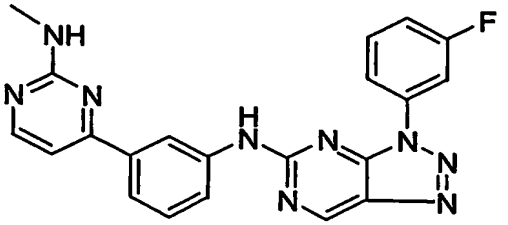
Example B4

a. Preparation of compound 35



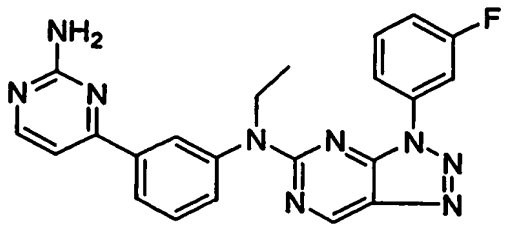
Intermediate 6b (0.00015 mol, 1 equiv.) was added to a solution of cyanoguanidine (0.00045 mol, 3 equiv.) in 2-ethoxyethanol (2 ml) and the mixture was stirred and refluxed for 2 hours, then stirred overnight at room temperature. CH_3ONa (0.00015 mol, 1 equiv.) and the resulting mixture was stirred and refluxed for 1 hour. Extra cyanoguanidine (0.00045 mol, 3 equiv.) and extra CH_3ONa (0.00045 mol, 3 equiv.) were added and then the reaction mixture was stirred and refluxed for 3 hours. The mixture was cooled and poured out into ice-water. The resulting precipitate was filtered off, washed with H_2O and dried (P_2O_5). Yield: 0.060 g of compound 35 (94 %)

b. Preparation of compound 34



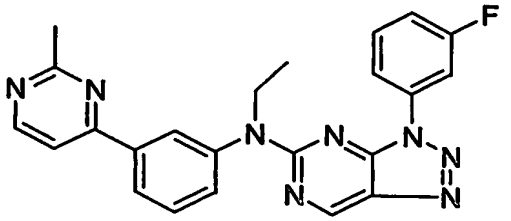
Methylguanidine (0.00075 mol, 3 equiv.) was added to a solution of CH_3ONa (0.00075 mol, 3 equiv.) in 2-ethoxyethanol (2 ml) and the resulting mixture was stirred for 30 minutes, then a suspension of intermediate 6b (prepared according to A2.e-1) (0.00025 mol, 1 equiv.) in 2-ethoxyethanol (1 ml) was added and the reaction mixture was stirred and refluxed for 4 hours. The mixture was cooled and poured out into ice-water. The resulting precipitate was filtered off, washed with H_2O and dried under vacuum and P_2O_5. Yield: 0.085 g of compound 34 (82 %).

c. Preparation of compound 70



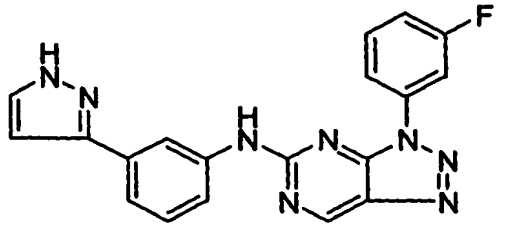
Guanidine (0.00075 mol, 3 equiv.) was added to a solution of CH_3ONa (0.00075 mol, 3 equiv.) in 2-ethoxyethanol (2 ml) and the resulting mixture was stirred for 30 minutes, then a suspension of intermediate 6c (prepared according to A2.e-2) (0.00023 mol, 1 equiv.) in 2-ethoxyethanol (3 ml) was added and the reaction mixture was stirred and refluxed for 2 hours. The mixture was cooled and poured out into ice-water. The resulting precipitate was filtered off, washed with H_2O and dried under vacuum and P_2O_5. Yield: 0.080 g of compound 70 (81 %).

d. Preparation of compound 69



Acetamidine HCl (0.00115 mol, 5 equiv.) was added to a solution of CH_3ONa (0.00115 mol, 5 equiv.) in 2-ethoxyethanol (q.s.) and the resulting mixture was stirred for 15 minutes, then intermediate 6c (prepared according to A2.e-2) (0.00023 mol, 1 equiv.) was added. The reaction mixture was heated at 130-135°C for 4 hours and stirred overnight at room temperature. A solution of acetamidine HCl (0.00069 mol, 3 equiv.) and CH_3ONa (0.00069 mol, 3 equiv.) in 2-ethoxyethanol (q.s.) was added and the reaction mixture was stirred and refluxed for 3 hours, then stirred overnight at 50°C. Extra acetamidine HCl (0.00115 mol, 5 equiv.) and extra CH_3ONa (0.00115 mol, 5 equiv.) were added, then the resulting reaction mixture was stirred and refluxed for 5 hours. Ice-cold water was added and the resulting precipitate was filtered off, then washed with H_2O. The solids were rinsed on the funnel with diethyl ether and were dissolved in 2-propanone. The solvent was evaporated to dryness and the residue was dissolved in 2-propanone. H_2O was added and the solvent was co-evaporated with CH_3CN, then the residue was dried (P_2O_5). Yield : 0.090 g of compound 69 (91%).

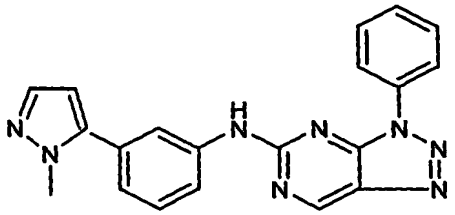
e. Preparation of compound 22

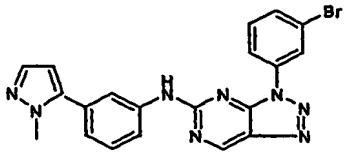


Intermediate 6b (prepared according to A2.e) (0.00015 mol, 1 equiv.) was added to a solution of hydrazine, anhydrous (0.030 g) in 2-ethoxyethanol (2 ml) and the reaction mixture was stirred and refluxed for 30 minutes. The solution was cooled and poured out into ice-water. The resulting precipitate was filtered off and washed on the funnel with H_2O. The residue was triturated on the funnel under Et_2O and then dried in vacuum under P_2O_5. Yield: 0.035 g of compound 22 (63 %).

Example B5

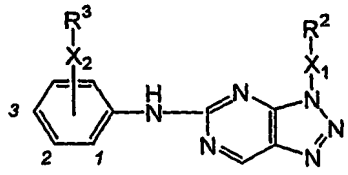
Preparation of compound 9

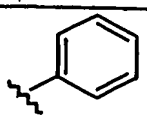
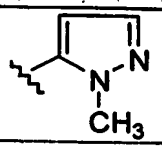
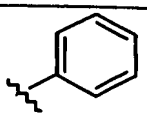
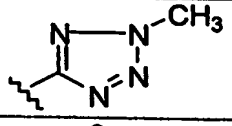
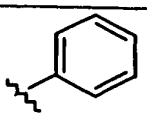
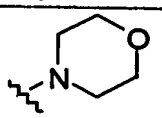
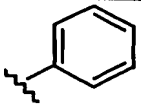
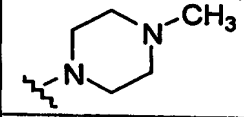
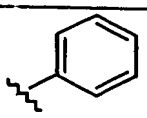
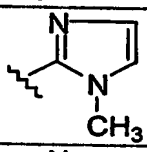
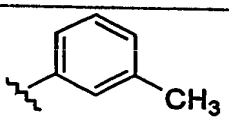
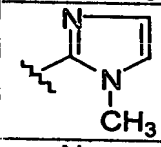
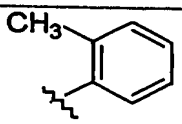
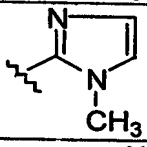
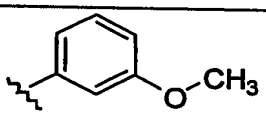
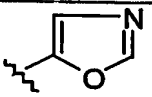
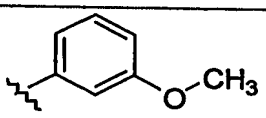
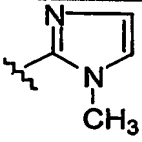
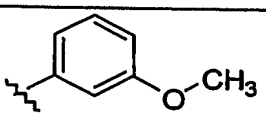
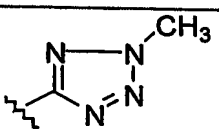


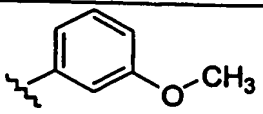
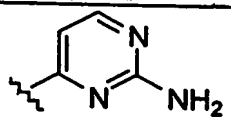
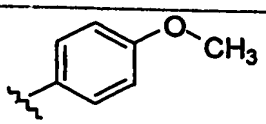
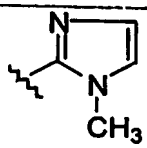
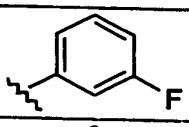
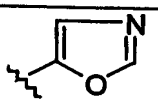
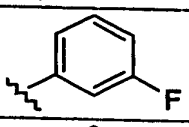
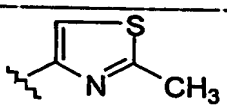
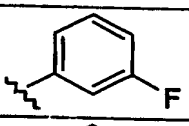
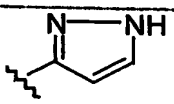
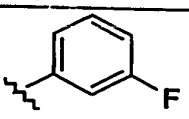
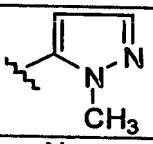
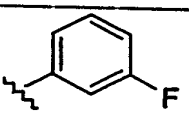
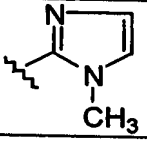
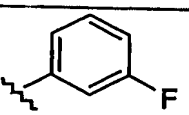
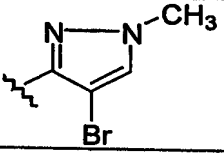
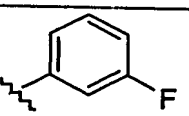
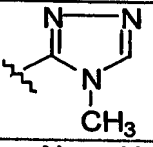
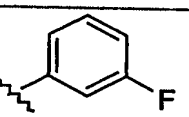
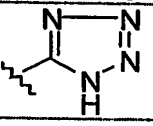
A mixture of  compound 8 (prepared according to B1.a) (0.00016 mol) and Et_3N (0.5 ml) in THF (40 ml) was hydrogenated with Pd/C 10% (0.02 g) as a catalyst in the presence of a solution of thiophene in DIPE (4% v/v, 0.01 ml). After uptake of H_2 (1 equiv.), the catalyst was filtered off and the filtrate was evaporated. The residue was crystallised from CH_3CN, the resulting precipitate was filtered off and dried. Yield: 0.029 g of compound 9 (m.p.: 216 °C).

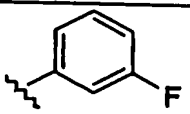
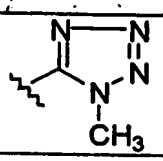
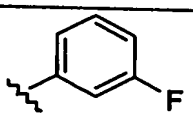
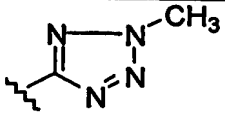
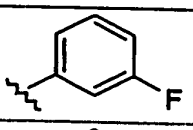
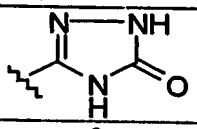
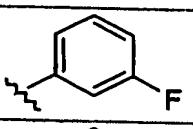
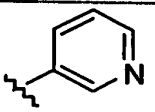
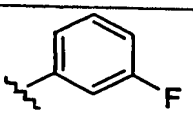
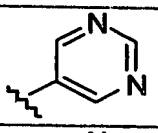
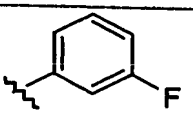
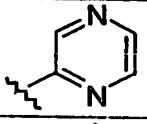
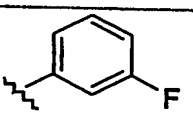
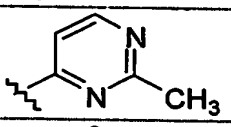
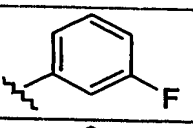
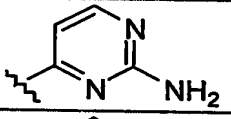
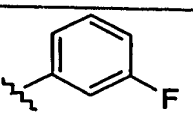
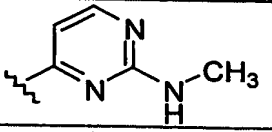
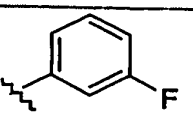
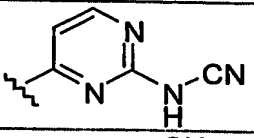
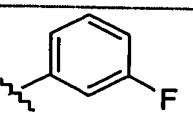
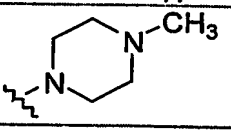
Tables 1 to 3 list the compounds of formula (I) which were prepared according to one of the above examples.

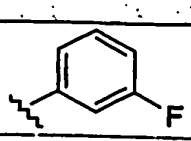
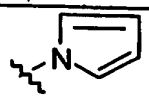
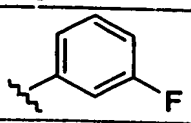
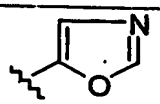
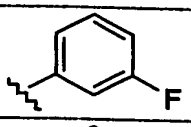
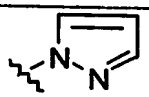
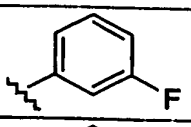
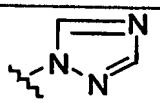
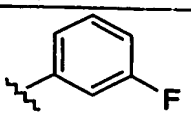
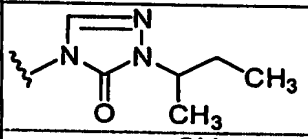
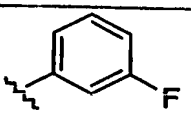
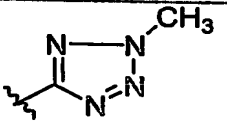
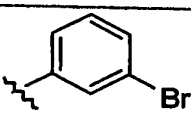
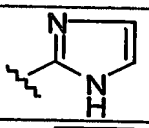
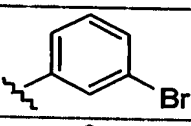
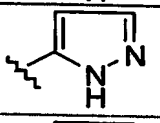
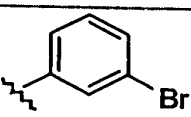
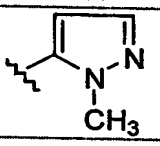
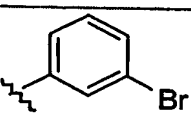
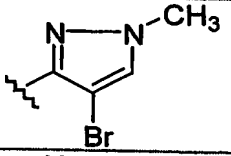
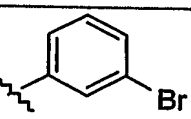
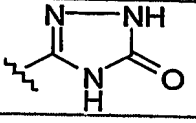
Table 1

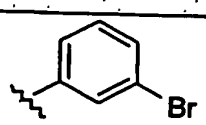
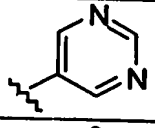
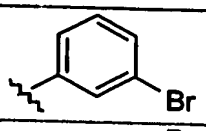
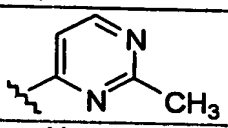
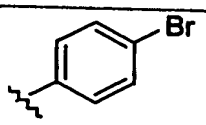
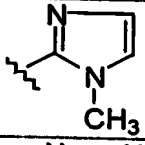
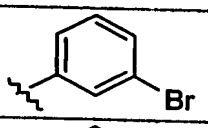
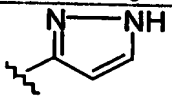
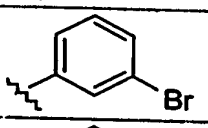
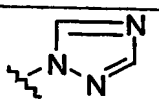
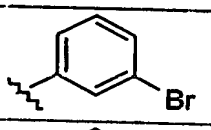
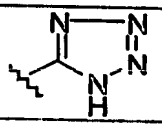
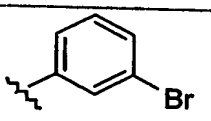
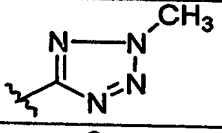
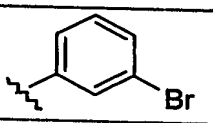
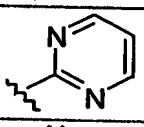
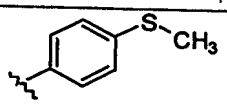
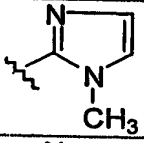
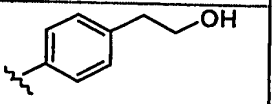
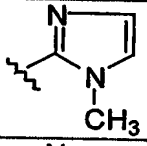
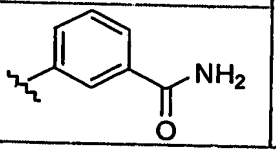
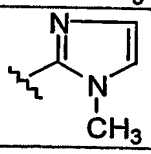


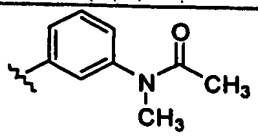
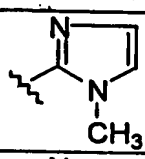
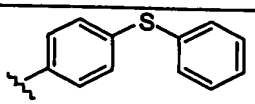
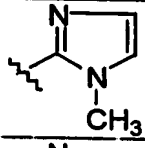
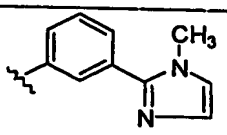
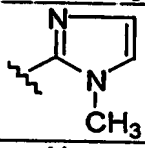
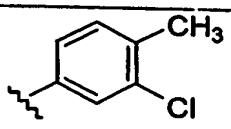
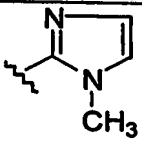
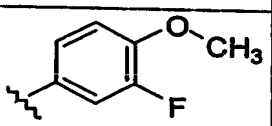
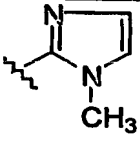
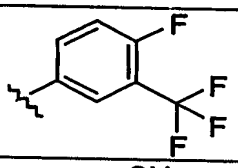
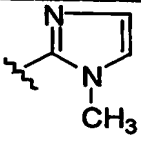
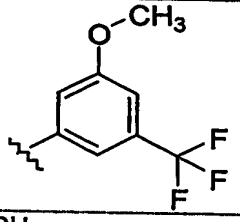
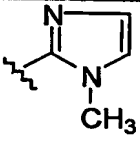
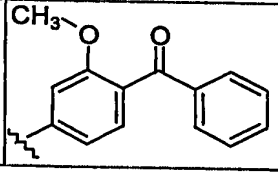
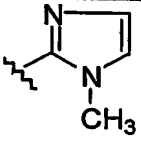
Co. no.	Ex. no.	X_1	R^2	X_2	R^3	physical data (m.p. °C)
9	B5	db		2-db		216
10	B5	db		3-db		244
11	B2a	db		3-db		
12	B2a	db		3-db		223
13	B2a	$-CH_2-$		2-db		
14	B2a	db		2-db		
15	B2a	db		2-db		
16	B1b	db		2-db		188
17	B2a	db		2-db		
18	B1b	db		2-db		242

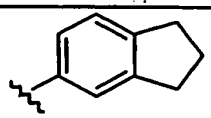
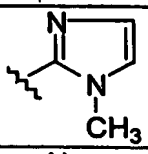
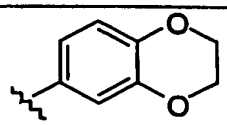
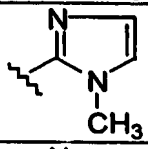
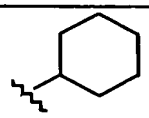
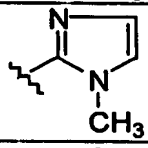
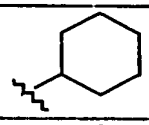
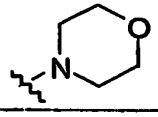
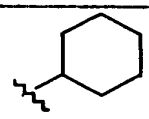
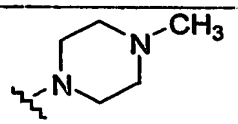
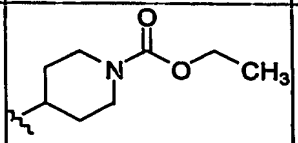
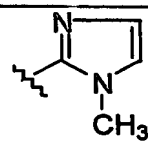
Co. no.	Ex. no.	X_1	R^2	X_2	R^3	physical data (m.p. °C)
19	B1b	db		2-db		244
3	B2b	db		2-db		
20	B1 b	db		2-db		232
21	B1a	db		2-db		256
22	B1a/ B4e	db		2-db		
23	B1a	db		2-db		232
24	B2a	db		2-db		
25	B1a	db		2-db		220
26	B1b	db		2-db		
27	B1b	db		2-db		>260

Co. no.	Ex. no.	X_1	R^2	X_2	R^3	physical data (m.p. °C)
28	B1b	db		2-db		258
29	B1b	db		2-db		>280
1	B1a	db		2-db		>260
30	B1a	db		2-db		210
31	B1a	db		2-db		>260
2	B1b	db		2-db		>260
32	B1a	db		2-db		
33	B1a	db		2-db		266
34	B4b	db		2-db		
35	B4a	db		2-db		
36	B1b	db		2-db		>250

Co. no.	Ex. no.	X_1	R^2	X_2	R^3	physical data (m.p. °C)
37	B1a	db		3-db		220
38	B1a	db		3-db		>260
39	B1a	db		3-db		244
40	B1a	db		3-db		>260
41	B1a	db		3-db		202
42	B1a	db		3-db		>260
43	B1a	db		2-db		>260
44	B1a	db		2-db		244
8	B1a	db		2-db		244
45	B1a	db		2-db		204
46	B1a	db		2-db		>260

Co. no.	Ex. no.	X_1	R^2	X_2	R^3	physical data (m.p. °C)
47	B1a	db		2-db		>260
48	B1a	db		2-db		
49	B1a	db		2-db		
50	B1a	db		3-db		>260
51	B1a	db		3-db		
52	B1a	db		3-db		175
53	B1a	db		3-db		247
54	B1a	db		3-NH-		>260
55	B2a	db		2-db		
56	B2a	db		2-db		
7	B3	db		2-db		

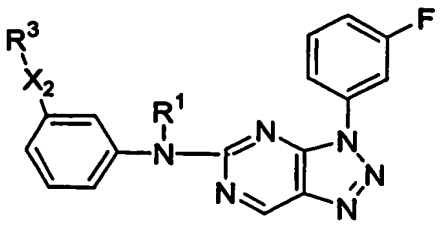
Co. no.	Ex. no.	X_1	R^2	X_2	R^3	physical data (m.p. °C)
57	B2a	db		2-db		
58	B2a	db		2-db		
59	B3	db		2-db		
60	B2a	db		2-db		
61	B2a	db		2-db		
62	B2a	db		2-db		
63	B2a	db		2-db		
64	B2a	db		2-db		

Co. no.	Ex. no.	X_1	R^2	X_2	R^3	physical data (m.p. °C)
65	B2b	db		2-db		
66	B2a	db		2-db		
67	B2a	db		2-db		
6	B2c	db		3-db		
4	B2b	db		3-db		167
68	B2a	db		2-db		

db = direct bond

m.p.= melting point

Table 2



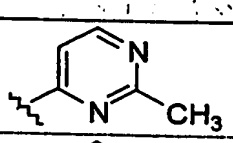
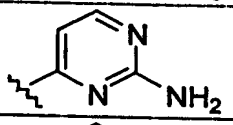
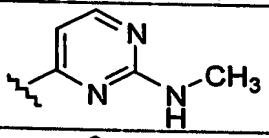
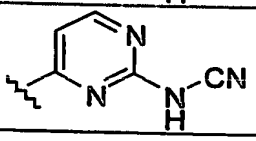
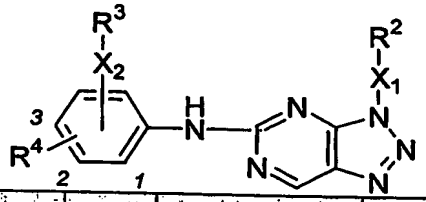
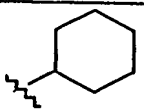
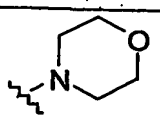
Co. no.	Ex. no.	R^1	X_2	R^3	physical data
69	B4d	$-CH_2-CH_3$	db		83
70	B4c	$-CH_2-CH_3$	db		
71	B4b	$-CH_2-CH_3$	db		196
72	B4a	$-CH_2-CH_3$	db		196

Table 3 :



Co. no.	Ex. no.	X_1	R^2	X_2	R^3	R^4	physical data (m.p. °C)
5	B2e	db		3-db		$2\text{-}NO_2$	162

db = direct bond
m.p. = melting point

C. Pharmacological Example

The pharmacological activity of the present compounds was examined using the following test.

GSK3beta assays were performed at 25°C in a 100 µl reaction volume of 25mM Tris (pH 7.4) containing 10 mM $MgCl_2$, 1 mM DTT, 0.1 mg/ml BSA, 5% glycerol and containing 19 nM GSK3β, 5 µM biotinylated phosphorylated CREB peptide , 1 µM ATP, 2nM ATP-P^{33} and a suitable amount of a test compound of formula (I). After one hour, the reaction was terminated by adding 70 µl of Stop mix (1 mM ATP, 18 mg/ml streptavidin coated PVT SPA bead pH 11.0). The beads to which the phosphorylated CREB peptide is attached were allowed to settle for 30 minutes and the radioactivity of the beads was counted in a microtiterplate scintillation counter and compared with the results obtained in a control experiment (without the presence of a test compound) in order to determine the percentage of GSK3β inhibition. The IC_{50} value, i.e. the concentration (M) of the test compound at which 50 % of GSK3β is inhibited, was calculated from the dose response curve obtained by performing the above-described GSK3β assay in the presence of different amounts of the test compound.

Table 4 lists ranges (namely pIC_{50} >8; pIC_{50} ranging between 7 and 8; pIC_{50} <7) of pIC_{50} values (-log IC_{50} (M)) obtained in the above-described test for the present compounds

Table 4

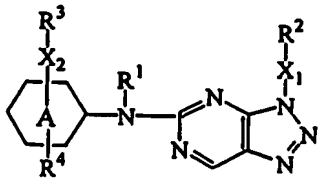
Compound no.	pIC_{50}
9	>8
11	7-8
12	<7
14	>8
17	>8
3	>8
20	>8
21	>8
22	>8
23	>8
24	>8
25	7-8

Compound no.	pIC_{50}
27	>8
1	>8
30	>8
31	>8
2	>8
32	>8
33	>8
34	>8
35	>8
36	>8
37	<7
38	7-8
39	7-8
40	>8
41	7-8
42	>8
43	>8
44	7-8
8	<7
45	7-8
46	7-8
47	>8
48	7-8
49	7-8
50	7-8
51	7-8
52	>8
53	7-8
55	7-8
56	7-8
7	7-8
57	<7
60	7-8
61	7-8

Compound no.	pIC_{50}
63	>8
65	>8
66	>8
68	>8
70	7-8
5	7-8

Claims

1. A compound of formula



(I),

a *N*-oxide, a pharmaceutically acceptable addition salt, a quaternary amine and a stereochemically isomeric form thereof, wherein

ring A represents phenyl, pyridyl, pyrimidinyl, pyridazinyl or pyrazinyl;

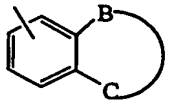
R^1 represents hydrogen; aryl; formyl; C_{1-6}alkylcarbonyl; C_{1-6}alkyl; C_{1-6}alkyloxycarbonyl; C_{1-6}alkyl substituted with formyl, C_{1-6}alkylcarbonyl, C_{1-6}alkyloxycarbonyl, C_{1-6}alkylcarbonyloxy; or C_{1-6}alkyloxyC_{1-6}alkylcarbonyl optionally substituted with C_{1-6}alkyloxycarbonyl;

X_1 represents a direct bond; C_{1-4}alkyl- or -C_{1-2}alkyl-X_{1a}-X_{1b}-;

with X_{1a} representing O or NR^5; and

with X_{1b} representing a direct bond or C_{1-2}alkyl;

R^2 represents C_{3-7}cycloalkyl; phenyl or a 4, 5, 6- or 7-membered monocyclic heterocycle containing at least one heteroatom selected from O, S or N; or a radical of formula



(a-1)

wherein –B-C- represents a bivalent radical of formula

–CH_2-CH_2-CH_2- (b-1);

–CH_2-CH_2-CH_2-CH_2- (b-2);

-X_3-CH_2-CH_2-$(CH_2)_n$- (b-3);

-X_3-CH_2-$(CH_2)_n$-X_3- (b-4);

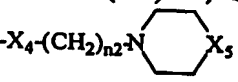
-X_3-$(CH_2)_{n'}$-CH=CH- (b-5);

with X_3 representing O or NR^5;

n representing an integer with value 0, 1, 2 or 3;

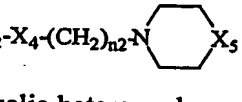
n' representing an integer with value 0 or 1;

wherein said R^2 substituent, where possible, may optionally be substituted with at least one substituent selected from halo; hydroxy; C_{1-6}alkyl optionally substituted with at least one substituent selected from hydroxy, cyano, carboxyl, C_{1-4}alkyloxy, C_{1-4}alkylcarbonyl, C_{1-4}alkyloxycarbonyl, C_{1-4}alkylcarbonyloxy, NR^6R^7, -C(=O)-NR^6R^7, -NR^5-C(=O)-NR^6R^7, -S(=O)$_{n1}$-R^8 or –NR^5-S(=O)$_{n1}$-R^8; C_{2-6}alkenyl or C_{2-6}alkynyl, each optionally substituted with at least one substituent selected from

hydroxy, cyano, carboxyl, C_{1-4}alkyloxy, C_{1-4}alkylcarbonyl, C_{1-4}alkyloxycarbonyl, C_{1-4}alkylcarbonyloxy, NR^6R^7, -C(=O)-NR^6R^7, -NR^5-C(=O)-NR^6R^7, -$S(=O)_{n1}$-R^8 or –NR^5-$S(=O)_{n1}$-R^8; polyhaloC_{1-6}alkyl; C_{1-6}alkyloxy optionally substituted with carboxyl; polyhaloC_{1-6}alkyloxy; C_{1-6}alkylthio; polyhaloC_{1-6}alkylthio; C_{1-6}alkyloxycarbonyl; C_{1-6}alkylcarbonyloxy; C_{1-6}alkylcarbonyl; polyhaloC_{1-6}alkylcarbonyl; cyano; carboxyl; NR^6R^7; C(=O)NR^6R^7; -NR^5-C(=O)-NR^6R^7; -NR^5-C(=O)-R^5; -$S(=O)_{n1}$-R^8; –NR^5-$S(=O)_{n1}$-R^8; -S-CN; -NR^5-CN or 

with n2 representing an integer with value 0, 1, 2, 3 or 4;
with X_4 representing O, NR^5 or a direct bond;
with X_5 representing O or NR^5;

X_2 represents a direct bond; -NR^1-; -O-; -C(=O)-; -C(=S)-; -S-; -$S(=O)_{n1}$-; -C_{1-4}alkyl-; or -C_{1-2}alkyl-X_{1a}-X_{1b}-;

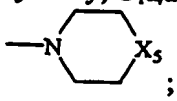
R^3 represents a 5-or 6-membered monocyclic heterocycle containing at least one heteroatom selected from O, S or N, wherein said R^3 substituent, where possible, may optionally be substituted with at least one substituent selected from halo; hydroxy; C_{1-6}alkyl optionally substituted with at least one substituent selected from hydroxy, cyano, carboxyl, C_{1-4}alkyloxy, C_{1-4}alkylcarbonyl, C_{1-4}alkyloxycarbonyl, C_{1-4}alkylcarbonyloxy, NR^6R^7, -C(=O)-NR^6R^7, -NR^5-C(=O)-NR^6R^7, -$S(=O)_{n1}$-R^8 or –NR^5-$S(=O)_{n1}$-R^8; C_{2-6}alkenyl or C_{2-6}alkynyl, each optionally substituted with at least one substituent selected from hydroxy, cyano, carboxyl, C_{1-4}alkyloxy, C_{1-4}alkylcarbonyl, C_{1-4}alkyloxycarbonyl, C_{1-4}alkylcarbonyloxy, NR^6R^7, -C(=O)-NR^6R^7, -NR^5-C(=O)-NR^6R^7, -$S(=O)_{n1}$-R^8 or –NR^5-$S(=O)_{n1}$-R^8; polyhaloC_{1-6}alkyl; C_{1-6}alkyloxy optionally substituted with carboxyl; polyhaloC_{1-6}alkyloxy; C_{1-6}alkylthio; polyhaloC_{1-6}alkylthio; C_{1-6}alkyloxycarbonyl; C_{1-6}alkylcarbonyloxy; C_{1-6}alkylcarbonyl; polyhaloC_{1-6}alkylcarbonyl; cyano; carboxyl; NR^6R^7; C(=O)NR^6R^7; -NR^5-C(=O)-NR^6R^7; -NR^5-C(=O)-R^5; -$S(=O)_{n1}$-R^8; –NR^5-$S(=O)_{n1}$-R^8; -S-CN; -NR^5-CN; or  ; and in case R^3 represents a saturated 5-or 6-membered monocyclic heterocycle containing at least one heteroatom selected from O, S or N, said R^3 may also be substituted with at least one oxo;

R^4 represents hydrogen; halo; hydroxy; C_{1-4}alkyl optionally substituted with at least one substituent selected from hydroxy, cyano, carboxyl, C_{1-4}alkyloxy, C_{1-4}alkylcarbonyl, C_{1-4}alkyloxycarbonyl, C_{1-4}alkylcarbonyloxy, NR^9R^{10}, -C(=O)-NR^9R^{10}, -NR^5-C(=O)-NR^9R^{10}, -$S(=O)_{n1}$-R^{11} or –NR^5-$S(=O)_{n1}$-R^{11}; C_{2-4}alkenyl or C_{2-4}alkynyl,

each optionally substituted with at least one substituent selected from hydroxy, cyano, carboxyl, C_{1-4}alkyloxy, C_{1-4}alkylcarbonyl, C_{1-4}alkyloxycarbonyl, C_{1-4}alkylcarbonyloxy, NR^9R^{10}, $-C(=O)-NR^9R^{10}$, $-NR^5-C(=O)-NR^9R^{10}$, $-S(=O)_{n1}-R^{11}$ or $-NR^5-S(=O)_{n1}-R^{11}$; polyhaloC_{1-3}alkyl; C_{1-4}alkyloxy optionally substituted with carboxyl; polyhaloC_{1-3}alkyloxy; C_{1-4}alkylthio; polyhaloC_{1-3}alkylthio; C_{1-4}alkyloxycarbonyl; C_{1-4}alkylcarbonyloxy; C_{1-4}alkylcarbonyl; polyhaloC_{1-4}alkylcarbonyl; nitro; cyano; carboxyl; NR^9R^{10}; $C(=O)NR^9R^{10}$; $-NR^5-C(=O)-NR^9R^{10}$; $-NR^5-C(=O)-R^5$; $-S(=O)_{n1}-R^{11}$; $-NR^5-S(=O)_{n1}-R^{11}$; -S-CN; $-NR^5-CN$;

R^5 represents hydrogen or C_{1-4}alkyl;

R^6 and R^7 each independently represent hydrogen; cyano; C_{1-6}alkylcarbonyl; C_{1-4}alkyloxyC_{1-4}alkyl; C_{1-4}alkyl-NR^5-C_{1-4}alkyl; C_{1-6}alkyl optionally substituted with hydroxy, C_{1-4}alkyloxy, C_{1-4}alkyloxyC_{1-4}alkyloxy, $NR^{6a}R^{7a}$, $C(=O)NR^{6a}R^{7a}$,



;

R^{6a} and R^{7a} each independently represent hydrogen; C_{1-4}alkyl; C_{1-4}alkylcarbonyl;

R^8 represents C_{1-4}alkyl, polyhaloC_{1-4}alkyl or NR^6R^7;

R^9 and R^{10} each independently represent hydrogen; C_{1-6}alkyl; cyano; C_{1-6}alkylcarbonyl; C_{1-4}alkyloxyC_{1-4}alkyl or C_{1-4}alkyl-NR^5-C_{1-4}alkyl;

R^{11} represents C_{1-4}alkyl or NR^9R^{10};

n1 represents an integer with value 1 or 2;

aryl represents phenyl or phenyl substituted with at least one substituent selected from halo, C_{1-6}alkyl, C_{3-7}cycloalkyl, C_{1-6}alkyloxy, cyano, nitro, polyhaloC_{1-6}alkyl and polyhaloC_{1-6}alkyloxy.

2. A compound as claimed in claim 1 wherein ring A is phenyl or pyridyl; R^1 is hydrogen or C_{1-6}alkyl; X_1 is direct bond or C_{1-4}alkyl; R^2 is phenyl; cyclohexyl; piperidinyl; indanyl; 2,3-dihydro-1,4-benzodioxanyl; said rings representing R^2 optionally being substituted with at least one substituent selected independently from C_{1-6}alkyl; C_{1-6}alkyloxy; halo; C_{1-6}alkylthio; hydroxyC_{1-6}alkyl; aminocarbonyl; (C_{1-6}alkyl)(C_{1-6}alkylcarbonyl)amino; polyhaloC_{1-6}alkyl; C_{1-6}alkyloxycarbonyl; X_2 is direct bond or NR^1; R^3 is tetrazolyl; morpholinyl; piperazinyl; imidazolyl; oxazolyl; oxadiazolyl; pyrimidinyl; thiazolyl; triazolyl; pyridyl; pyrazinyl; pyrazolyl; pyrrolyl; said rings representing R^3 optionally being substituted with at least one substitutent selected independently from C_{1-6}alkyl; amino; halo; hydroxy; mono(C_{1-6}alkyl)amino; -NH-CN; R^4 is hydrogen or nitro.

3. A compound as claimed in claim 1 or 2 wherein ring A is phenyl; R^1 is hydrogen; X_1 is direct bond; R^2 is indanyl; 2,3-dihydro-1,4-benzodioxanyl; phenyl optionally being substituted with 1 or 2 substituents each independently being selected from C_{1-6}alkyl, in particular methyl; C_{1-6}alkyloxy, in particular methoxy; halo, in particular fluoro, or polyhaloC_{1-6}alkyl, in particular trifluoromethyl; X_2 is direct bond; R^3 is tetrazolyl; piperazinyl; imidazolyl; oxazolyl; pyrimidinyl; thiazolyl; triazolyl; pyridyl; pyrazinyl; pyrazolyl; said rings representing R^3 optionally being substituted with one substitutent selected from C_{1-6}alkyl, in particular methyl; amino; hydroxy; mono(C_{1-6}alkyl)amino, in particular methylamino; -NH-CN; R^4 is hydrogen.

4. A compound as claimed in any one of claims 1 to 3 wherein the compound is selected from
3-(3-Fluoro-phenyl)-3H-[1,2,3]triazolo[4,5-d]pyrimidin-5-yl]-(3-oxazol-5-yl-phenyl)-amine;
[3-(3-Fluoro-phenyl)-3H-[1,2,3]triazolo[4,5-d]pyrimidin-5-yl]-[3-(1-methyl-1H-tetrazol-5-yl)-phenyl]-amine;
[3-(2-Amino-pyrimidin-4-yl)-phenyl]-[3-(3-fluoro-phenyl)-3H-[1,2,3]triazolo[4,5-d]pyrimidin-5-yl]-amine;
[3-(3-Fluoro-phenyl)-3H-[1,2,3]triazolo[4,5-d]pyrimidin-5-yl]-(3-pyrimidin-5-yl-phenyl)-amine; a *N*-oxide, a pharmaceutically acceptable addition salt, a quaternary amine and a stereochemically isomeric form thereof.

5. A compound as claimed in any one of claims 1 to 4 for use as a medicine.

6. The use of a compound as defined in any one of claims 1 to 4 for the manufacture of a medicament for the prevention or the treatment of diseases mediated through GSK3.

7. The use of a compound as defined in any one of claims 1 to 4 for the manufacture of a medicament for the prevention or the treatment of bipolar disorder (in particular manic depression), diabetes, Alzheimer's disease, leukopenia, FTDP-17 (Fronto-temporal dementia associated with Parkinson's disease), cortico-basal degeneration, progressive supranuclear palsy, multiple system atrophy, Pick's disease, Niemann Pick's disease type C, Dementia Pugilistica, dementia with tangles only, dementia with tangles and calcification, Down syndrome, myotonic dystrophy, Parkinsonism-dementia complex of Guam, aids related dementia, Postencephalic Parkinsonism, prion diseases with tangles, subacute sclerosing panencephalitis, frontal lobe degeneration (FLD), argyrophilic grains disease, subacute sclerotizing

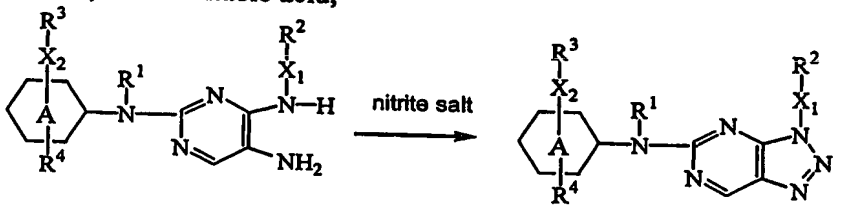
panencephalitis (SSPE) (late complication of viral infections in the central nervous system), inflammatory diseases, cancer, dermatological disorders, neuroprotection, schizophrenia, pain.

8. The use of a compound as claimed in claim 7 for the prevention or the treatment of Alzheimer's disease, diabetes, cancer, inflammatory diseases or bipolar disorder.

9. A pharmaceutical composition comprising a pharmaceutically acceptable carrier and as active ingredient a therapeutically effective amount of a compound as claimed in any one of claims 1 to 4.

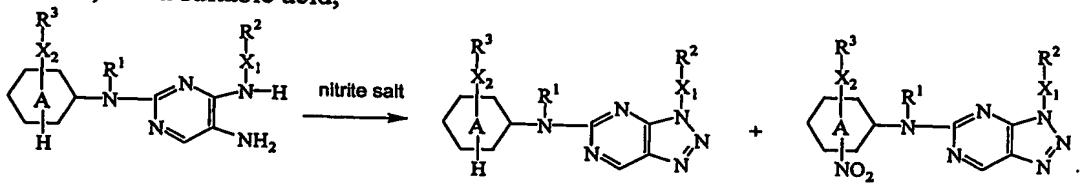
10. A process for preparing a pharmaceutical composition as claimed in claim 9 characterized in that a therapeutically effective amount of a compound as claimed in any one of claims 1 to 4 is intimately mixed with a pharmaceutically acceptable carrier.

11. A process for preparing a compound as claimed in claim 1, characterized by
a) cyclizing an intermediate of formula (II) in the presence of a nitrite salt, a suitable solvent, and a suitable acid,



(II) (I)

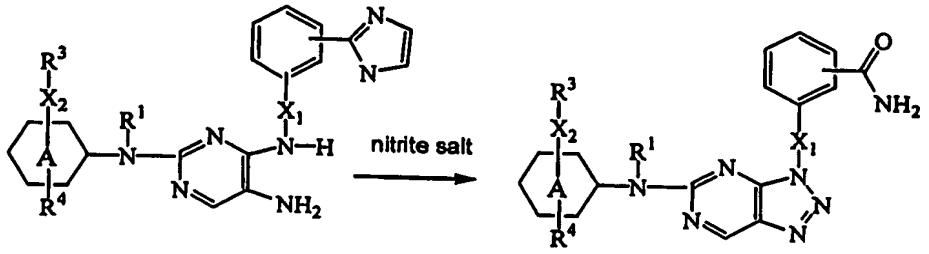
wherein ring A, R^1 to R^4, X_1 and X_2 are as defined in claim 1;
b) cyclizing an intermediate of formula (II-a) in the presence of a nitrite salt, a suitable solvent, and a suitable acid,



(II-a) (I-a) (I-b)

wherein ring A, R^1 to R^3, X_1 and X_2 are as defined in claim 1;

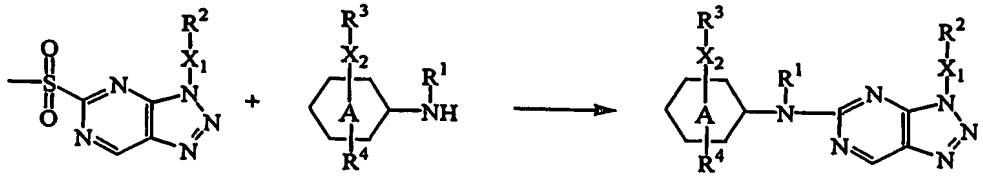
c) cyclizing an intermediate of formula (II-b) in the presence of a nitrite salt, a suitable solvent, and a suitable acid,



(II-b) (I-c)

wherein ring A, R^1, R^3 and R^4, X_1 and X_2 are as defined in claim 1;

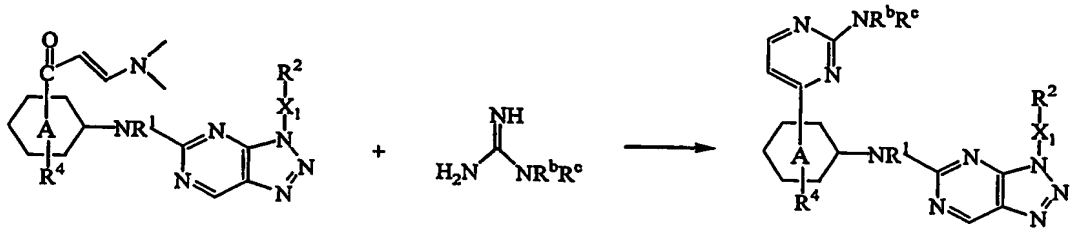
d) reacting an intermediate of formula (III) with an intermediate of formula (IV) in the presence of a suitable solvent,



(III) (IV) (I)

wherein ring A, R^1 to R^4, X_1 and X_2 are as defined in claim 1;

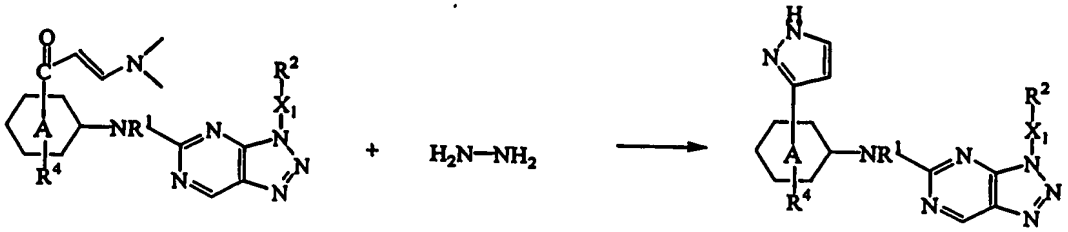
e) reacting an intermediate of formula (XV) with an intermediate of formula (XVI), wherein R^b represents hydrogen, C_{1-4}alkyl or cyano, and R^c represents hydrogen or C_{1-4}alkyl, in the presence of a suitable solvent and a suitable salt



(XV) (XVI) (I-d)

wherein ring A, R^1 R^2, R^4 and X_1 are as defined in claim 1;

f) reacting an intermediate of formula (XV) with hydrazine in the presence of a suitable solvent,



(XV) (I-e)

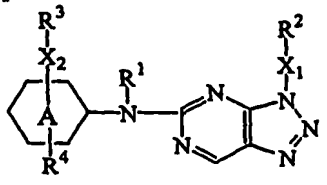
wherein ring A, R^1 R^2, R^4 and X_1 are as defined in claim 1;

or, if desired, converting compounds of formula (I) into each other following art-known transformations, and further, if desired, converting the compounds of formula (I), into a therapeutically active non-toxic acid addition salt by treatment with an acid, or into a therapeutically active non-toxic base addition salt by treatment with a base, or conversely, converting the acid addition salt form into the free base by treatment with alkali, or converting the base addition salt into the free acid by treatment with acid; and, if desired, preparing stereochemically isomeric forms, quaternary amines or *N*-oxide forms thereof.

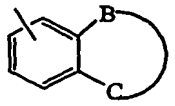
ABSTRACT

TRIAZOLOPYRIMIDINE DERIVATIVES AS GLYCOGEN SYNTHASE KINASE 3 INHIBITORS

This invention concerns compounds of formula


(I),

a *N*-oxide, a pharmaceutically acceptable addition salt, a quaternary amine and a stereochemically isomeric form thereof, wherein ring A represents phenyl, pyridyl, pyrimidinyl, pyridazinyl or pyrazinyl; R^1 represents hydrogen; aryl; formyl; C_{1-6}alkylcarbonyl; C_{1-6}alkyl; C_{1-6}alkyloxycarbonyl; substituted C_{1-6}alkyl; or optionally substituted C_{1-6}alkyloxyC_{1-6}alkylcarbonyl; X_1 represents a direct bond; C_{1-4}alkyl- or -C_{1-2}alkyl-X_{1a}-X_{1b}-; R^2 represents C_{3-7}cycloalkyl; phenyl or a 4, 5, 6- or 7-membered monocyclic heterocycle containing at least one heteroatom selected from O, S or N; or a radical of formula


(a-1)

wherein said R^2 substituent may optionally be substituted; X_2 represents a direct bond; -NR^1-; -O-; -C(=O)-; -C(=S)-; -S-; -S(=O)$_{n1}$-; -C_{1-4}alkyl-; or -C_{1-2}alkyl-X_{1a}-X_{1b}-; R^3 represents a 5-or 6-membered monocyclic heterocycle containing at least one heteroatom selected from O, S or N, wherein said R^3 substituent may optionally be substituted; R^4 represents hydrogen; halo; hydroxy; optionally substituted C_{1-4}alkyl; C_{2-4}alkenyl or C_{2-4}alkynyl, each optionally substituted; polyhaloC_{1-3}alkyl; optionally substituted C_{1-4}alkyloxy; polyhaloC_{1-3}alkyloxy; C_{1-4}alkylthio; polyhaloC_{1-3}alkylthio; C_{1-4}alkyloxycarbonyl; C_{1-4}alkylcarbonyloxy; C_{1-4}alkylcarbonyl; polyhaloC_{1-4}alkylcarbonyl; nitro; cyano; carboxyl; NR^9R^{10}; $C(=O)NR^9R^{10}$; -NR^5-C(=O)-NR^9R^{10}; -NR^5-C(=O)-R^5; -S(=O)$_{n1}$-R^{11}; -NR^5-S(=O)$_{n1}$-R^{11}; -S-CN; -NR^5-CN; their use, pharmaceutical compositions comprising them and processes for their preparation.